# POPULAR SCIENCE

MONTHLY

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## How Tough is U.S.? INDUSTRY ARMS AMERICA IN GREAT DEFENSE BATTLE


# but here is one worry you can avoid

A misplaced ring may upset the ceremony for the moment, but you can at least drive away on your honeymoon with the same Peace of Mind about your car as you get from your insurance policy—if you have had your Texaco Dealer give your car a Marfak job.

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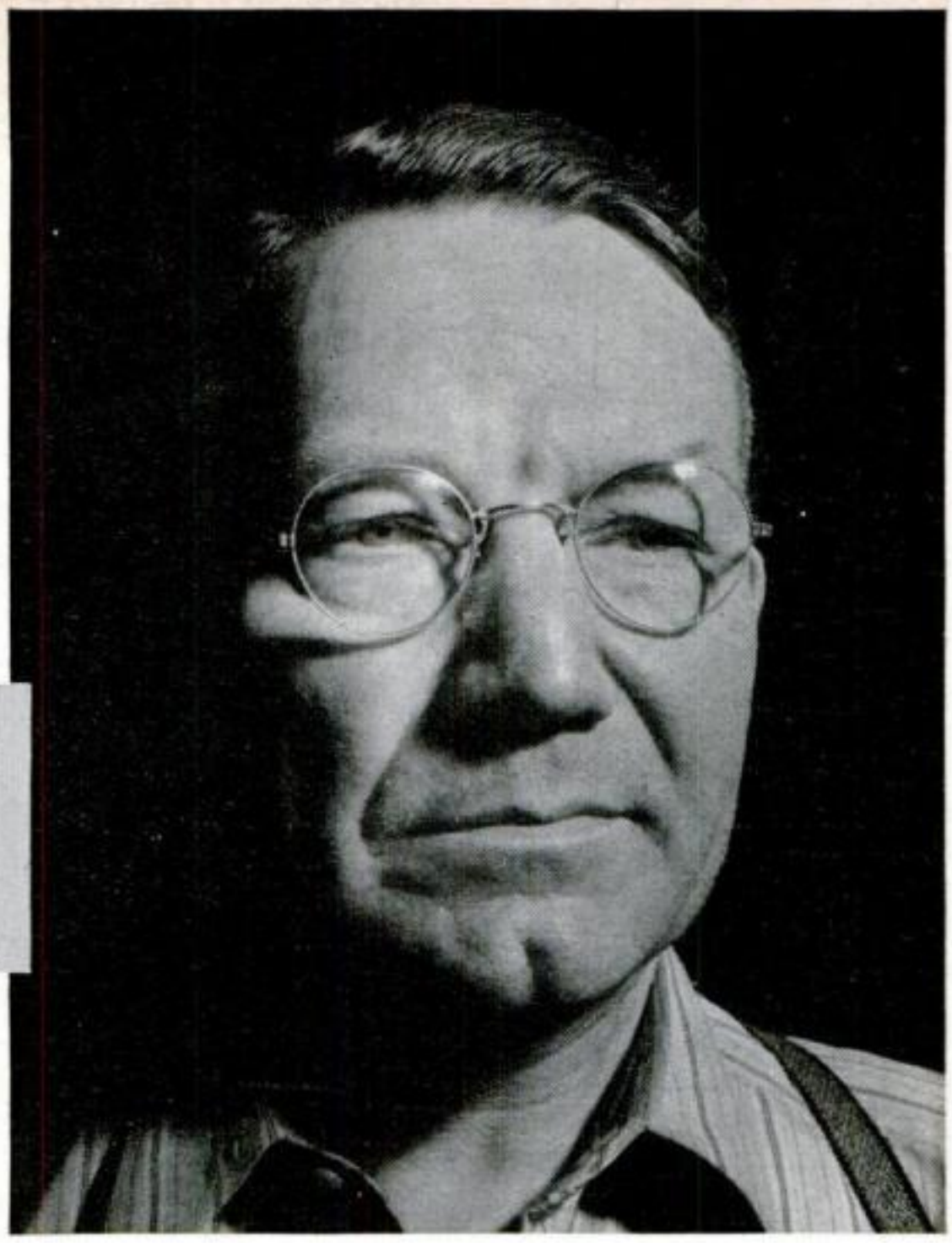

# VETERAN

HE is independent and proud, yet democratic and gregarious. He is the envy of the rest of the world, and its hope. He is generous, tolerant, peace-loving—and withal the most powerful man in the world. He is the American workman.

His hands, accustomed to the feel of wrench and lever and gauge, may never have held a gun; his mind, trained to think in terms of tolerances as fine as 1/10,000 of an inch, may never have wrestled with a problem of military strategy; and yet he is the veteran of a thousand campaigns.

His campaigns began in the laboratories, and his prowess was proved in the test pits of American industry. His battles were waged on the factory floor and in the field. His victories have helped to make the citizens of the United States the most fortunate people in the world, and the U. S. the greatest nation.

In the plants of the General Electric Company, working with General Electric scientists and engineers, this man, the American workman, has made giant generators to light whole cities, X-ray tubes to penetrate the mysteries of human flesh and metal castings, radio and television apparatus to project man's voice and image through space over the mysterious waves of the ether.

Today, in the gravest hour of world history, he is engaged in the greatest campaign of all. But there is serenity and confidence in his face, and the experience of a thousand campaigns behind him. He is sure of his own abilities, certain of his country's future. General Electric Co., Schenectady, New York.

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952-218E1-211

# POPULAR SCIENCE

FOUNDED 1872 MONTHLY VOL. 139-NO. 2

**Mechanics & Handicraft**

THE NEWS PICTURE MAGAZINE OF SCIENCE AND INDUSTRY


## CONTENTS *for* AUGUST, 1941

### *News*



### *Automobiles*



### *Home and Workshop*



### *Departments*




MATT MURPHEY, Chief Quartermaster, U.S.N., who illustrated the Navy article on page 86, is an artist in uniform. Joining the Navy in 1916, he served on the cruiser *Frederick* in the World War and studied art by correspondence. Today he is staff artist at national headquarters of the Navy Recruiting Bureau, turning out "join-the-Navy" posters that are printed in 50,000 and 100,000 lots.




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# SURE YOUR  'S IN THE RIGHT PLACE . . . BUT WHERE'S YOUR  ?

PATRIOTISM of the heart is vitally important today . . . for only those who love this country can be trusted in its defense.

But it isn't enough!

For your heart may be in the right place — but unless there is sound, up-to-date *knowledge* and *training* in your head, you can't help in the important tasks which face America today, when one *trained man* is worth a hundred jacks-of-all-trades! In fact, you may even be a hindrance!

Get the training you need to play *your* part in the defense program, and to achieve *success* in your line of work. Get it *quickly*, at *low cost*, by studying an I. C. S. Course in your spare time, in your own home. Mail this coupon for complete information, without obligation — and mail it *right now!*

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## New Shop Ideas



## Outdoors



## Photography



## Radio



*(Continued on page 6)*

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## The Handy Man



## Woodworking

HOW LONG? HOW LONG?
THIS HEART-BREAKING
MONOTONY?
THIS WRETCHED PAY?

# "If I Could Only Recover Those Ten Lost Years!"

[ The True Experience of a Man Who *Almost* Enrolled for LaSalle Home-Study Training ]

In December, 1921, an American employed with a mining firm in Mexico, clipped and signed a LaSalle advertisement coupon. *But he did not enroll!*

Ten years of silence followed . . . ten years of haphazard jobs, long hours, wretched pay . . .

Then, in January, *nineteen thirty two*, that silence was broken by a dramatic letter, high-spotted by these words: "*Please send the first lessons with the least possible delay, as time is a highly important factor to me in this year of our Lord!*"

Through five typewritten pages he recounted the hardships of those intervening years. A really able man, he had moved from one position to another, only to find advancement closed to him for lack of specialized training.

No need here to recite those hardships—though in justice to him it is only fair to say that on four separate occasions he had *almost* enrolled . . . and that on each occasion he had postponed action because of some unexpected reverse seemingly beyond his power to avoid.

"For five months now," so he wrote, "I have been 'on vacation.' Not a chance to take a course now—according to my carefully laid out and conscientiously followed program . . .

"But—supposing I had *chucked* that program at any time in the last 10 years? Supposing I had enrolled, in the face of seeming disaster, even though I had had to borrow the money to do it? Supposing even that I had enrolled only five months ago, at the beginning of my enforced vacation? In all likelihood I could have mastered the training by now. Or I might in the meanwhile have found a congenial and profitable position, thanks to my increased knowledge. As it is, for all I know, there may be another five months without any position . . . with all sorts of dim prospects . . . and meanwhile I am getting older . . .

"*That settles it! To blazes with further procrastination! To thunderation with my financial program! I've borrowed the money, and I'll borrow some more . . . but I'll do something with my time! This year is going to see a big change in my affairs—and right here is where we start!*"

## Send for Free Booklet

These are searching times—and wise is the man who takes full measure of his competition . . . gets the special training that he needs . . . and thus commands the unfolding opportunities of our new-day business world.

If you need to be *convinced* of those opportunities, forget that you ever read this message. For those opportunities are not for you . . .

But if you are determined to be out in front when men are picked for leadership one year, two years, ten years from now—do not, on your life, risk a day's delay.

Below is a coupon. It will bring you—without cost—books that have led to increased earnings running into many thousands of dollars! Men of action—*hundreds of them*—will use this coupon for their personal advancement. Be one of those men who will steadily win their way to the better-salaried positions.


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Name_____ Age_____

Position_____ Address_____

From the News Editor's Desk

RUBBER ARMOR saves British lives in air raids. The pressure wave of an explosion often causes deaths from hemorrhage, even when the victim is not struck by shrapnel or debris. Thick layers of rubber absorb the pressure. Dr. Alfred Blalock, of Vanderbilt University, who brought this news to the American Heart Association, also reported that injection of whole blood or plasma was the most effective treatment for shock. He told of a patient in desperate condition who was given seven pints of blood and plasma in a few hours. Twenty-four hours later his condition was good. Dr. Blalock warned against warming the hands and feet of victims of shock. He pointed out that they were cold because blood had been diverted to more vital needs.

NEW BROACHING TOOLS have reduced the time it takes to rifle big guns at the Army's Watervliet Arsenal to from a fourth to a fifth what it was. This is the most exacting part of the manufacturing process, and to rifle a 37-mm. cannon formerly took eight hours; now it takes two. Similarly a three-inch gun is rifled in three hours, instead of 16. Extensive use of cemented-carbide tools has also accelerated production.

SKIM MILK, now largely thrown away, and other surplus foods will soon be dried to preserve them, reduce storage space and shipping costs, yet have them available when needed. At the end of the war they will form a giant Community Chest Fund for feeding the people of the world.

A "SOLAR HOUSE" near Chicago gets a fifth of its heat from the sun. The architect, George Fred Keck, provided broad, glassed areas open to the slanting rays of winter sunlight but screened from summer's vertical sunshine. They kept the house at 72 degrees Fahrenheit during the six midday hours last winter, even when the outside temperature averaged below zero all day. Steam, operated automatically by a thermostat, rarely went on before 3 p. m.

A DIET FOR DEFENSE is offered by Dr. Lydia J. Roberts, head of the University of Chicago's department of home economics, to build health, strength, and morale. It is a pint of milk daily for an adult, more for children; one meat dish; an egg; two vegetables, one green or yellow; two servings of fruit, one citrus or tomatoes; whole-grain bread, flour, cereal; butter, or vitamin-enriched margarine; other foods to satisfy the appetite.

# Readers Say:

## An Article in P.S.M. Suggested This Streamlined Land Cruiser

AN ARTICLE you published about a year ago, on a combined automobile and trailer, gave me an idea. The photograph shows the result, built in spare time over half a year at a cost of $250. A frame of welded metal tubing over a Ford V8 chassis is covered with sheet metal. Over the engine is a metal framework supporting a table. Where the dashboard was originally, is a place for a stove. Covers over the front wheels make seats for two at the table. Back of the driver's seat there is room to install two bunks as in a trailer. Running boards are inclosed and are at the level of the bottom of the body. Windows slide as on a station wagon, and there are doors for oil filler, oil gauge, and gasoline filler pipe. Building the framework over the wheels gives extra room and eliminates fenders.—M. C. P., Downey, Calif.

## You'd Think He'd See Enough of Planes

SINCE joining the Royal Canadian Air Force I have looked forward to receiving each month's copy of P.S.M., and am never disappointed with its contents. You are keeping up your fine standard. Reading the letters in Our Readers Say and laughing at the drawings, which are always quite apt, is a good beginning for the pleasure I get out of reading the pages that follow. As an electrician in the R.C.A.F., I would like to see something on the construction of airplanes.—H. F. P., St. Thomas, Ont.


## Steam-Engine Model Saves a Subscriber

AND I was just about to sever relations with you forever! But at the last minute you publish plans for a steam-engine model. After all these years of waiting for something "up my alley!" Can't we have more of this type of material? After all, a steam engine is a live thing. Who cares about making the Statue of Liberty in toothpicks? Some do, of course—and a radio that fits in your hat. The boat-building section is fine—nothing as good in any other magazine. After all, we subscribers are getting our money's worth. But I insist on model steam engines. Let's have more of them!—Dr. L. M. MacC., Waterville, N. Y.

## And Who Said Mathematics Was a Dry Subject?

THOSE droplets, dewlets, and foglets in R.H.'s problem must have gone to his head, because his solution is all wet. I racked my own brain for a long time before I finally decided that there are 75,600 foglets in a drop.—T. B., Plattsburg, N. Y.

## Some People Collect Bugs Without Half Trying

WHY NOT publish more articles about insects? I am a sort of amateur entomologist and I think that others would enjoy knowing about this fascinating hobby. Most people think that the insect collector is a nut and laugh at the idea of collecting "bugs." But publish an article on insects and watch the interest pick up all over the country!—D. D. D., Morristown, Tenn.

# Readers Say:

## He Wants to Know What to Do with Those Shirt Cardboards


Now that you have dug up uses for empty cheese boxes, discarded Venetian-blind slats, and what-have-you, other readers might be as interested as I am in a project for using the cardboards that come back in shirts from the laundry. I have 22 cardboards on hand that I don't know what to do with, and I would like some advice.—C. C. M., Burlington, Vt.

## That Radio Turns His Bed into a Magic Carpet

HAVING recently built the two-tube bed radio described in your April issue, I want to thank you for the circuits you publish. With a 25-foot antenna, my bed radio receives stations from coast to coast with fine volume and selectivity. In fact, WABC (New York) and KFI (Los Angeles) were brought in with the volume only half on. I used a five-inch P.M. speaker.—C. H. R., Springfield, Ohio.

## Apparently the Balloon "Got High" on Pay Day

IN CONNECTION with your article about the Army's balloon-barrage squadron, you may be interested to know that a captive barrage balloon similar to those used in Britain has been in use at Gray Field (Fort Lewis) for more than a month. The balloon almost got away from her new masters one pay day, providing an exciting spectacle for bystanders. The blimp which you illustrated putters about overhead continually, snooping on our activities at camp and in the field.—Pvt. C. B., Fort Lewis, Wash.


## Who'll Have Ersatz Chorus Girls When Real Ones Are Plentiful?

I HAVE noticed a very interesting phenomenon several times when taking down the storm sash in the spring. Upon stacking the storm windows against the wall, one on top of another, the panes of glass are spaced at an even distance from each other. As I store the windows in a rather dark corner, each plate of glass acts as a mirror. So if an object is moved in front of the windows, it looks like a whole series of the same motion in perfect rhythm. Every motion that I make is repeated like a set of chorus girls doing that same motion. If motion-picture producers could make use of this principle, we would have perfectly synchronized actions in our stage-show scenes. One beautiful girl and we would have a whole set of them.—P. E. T., Milwaukee, Wis.


## That's All Right, But Don't Try It on the Gas Tank


G. A., of New York, need not be afraid of any terrific explosion from a storage battery. I have ignited a match and then stuck the live coal on the end into batteries many times just to hear them pop when the hydrogen exploded. And that floating hockey puck that somebody wanted could be made of wood with rubber edges.—R. M., Kings Valley, Ore.

## P. S. M. Helps Him Keep Up with Science and Invention

HAVING been in the model and experimental business for 40 years, I have found that observation is of major importance in the field of invention. Your magazine is a source of unlimited thought and refreshing reading, keeping me in touch with modern science and inventions. It is a pleasure to speak in the highest terms of P.S.M. and wish you years of continued success.—H. F. S., Edgewood, R. I.

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# Coming Next Month—

CIVILIAN DEFENSE COUNCILS are being organized all over the country. What will be your rôle when your community organizes? Air-raid warden, spotter, first aid, emergency fireman, emergency policeman? David M. Stearns takes a typical town and, with Ralph Morse's photographs, gives you a behind-the-scenes view of the civil defense program.

THE COFFEE BEAN is a wondrous new source of cheap plastics as well as of America's national drink. You may soon have a house made from it! Read how the burning of Brazil's gigantic surplus to keep up the price haunted a young Californian, and what he and Brazil are doing to turn that huge annual loss into an asset.

GLENN L. MARTIN, an aviator in 1909, a builder of bombers in 1941, tells what he sees for aviation after the war, in an interview by Roger Burlingame. Will weeds grow up around the big plane plants we are erecting now, or will peacetime requirements be as great or perhaps exceed the war's demand? Martin's judgement will surprise you, yet it has proved plenty sound in the past.

RUBBER has 25,000 wartime jobs! And it is constantly stretching out to take on more and more. Where are we going to get this basic material if war flames across the long road to the East Indies? It will be years before synthetics can supply more than a twentieth of our needs! What is the answer? South America? Africa? Is there a possibility you will have to jack up your automobile for lack of tires? Charles Morrow Wilson has packed all the available facts into an absorbing article.

CAMERA-BUS TRIPS into the country provide a way to attract the interest of photographic club members while the weather is still warm. "Camera Bus" gives some helpful pointers on organizing them, from planning the junket and charting the bus to rules for dealing with the farmer, his bees, and bull.

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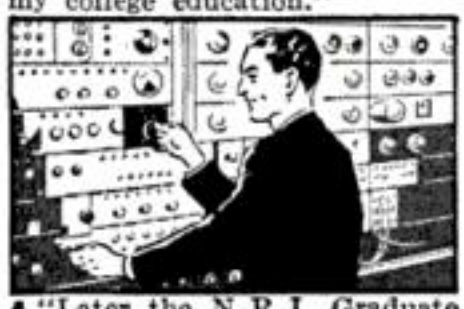
*by* S. J. E.
(NAME AND ADDRESS SENT UPON REQUEST)


1 "I had an $18 a week job in a shoe factory, but desired to make more money and continue my education. I read about Radio opportunities and enrolled with National Radio Institute."

2 "The instruction I received was so practical I was soon able to earn $5 to $10 a week in spare time servicing Radios. This paid for the N. R. I. Course and led to service work paying for my college education."

3 "Radio servicing permitted me to attend school and work evenings and week-ends. Upon completing the N. R. I. Course I was made Service Manager at $40 to $50 a week, more than twice my former wage."



4 "Later the N. R. I. Graduate Service Department sent me to Station KWCR as a Radio Operator. Now I am Radio Engineer of Station WSUI and connected with Television Station W9XK."

5 "The N. R. I. Course took me out of a low-pay shoe factory job and put me into Radio at good pay; enabled me to earn funds for a college education. There's a promising future for thoroughly trained Radio men."

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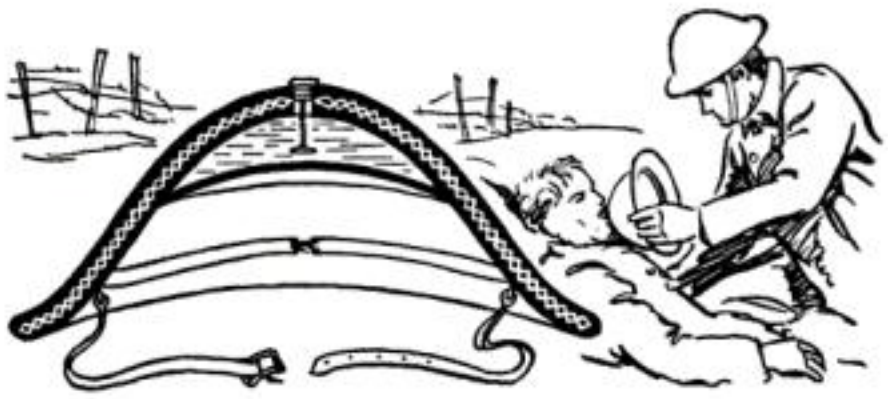
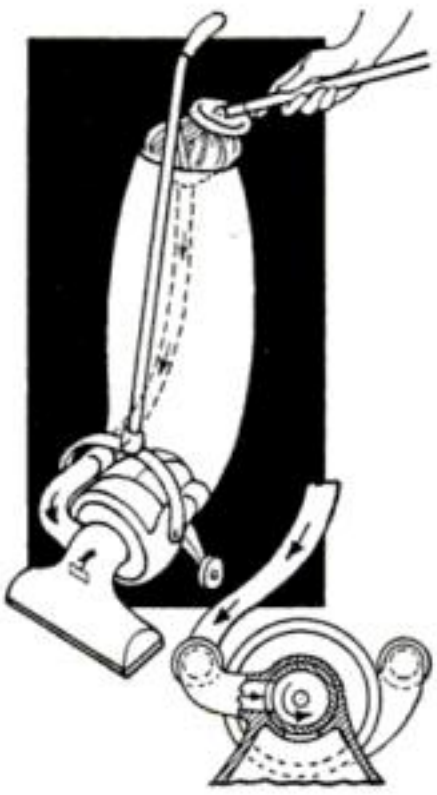
# With the Inventors

BY PROVIDING a reservoir for water in the crown of a military helmet, Thomas B. Upchurch, Jr., of Raeford, N. C., accomplishes a double purpose. First, an emergency supply of water is assured the wearer. Second, the water chamber



with its flexible bottom makes a comfortably resilient support for the headgear. A knurled nut at the top of a filler hole permits the contents to be emptied or replenished. For the conventional steel construction, the new helmet substitutes a bullet-resisting wire mesh of high tensile strength, covered inside and out by rubberized fabric. This results, the inventor says, in a headpiece of light weight, which will not betray the wearer's location by glinting in the sun or by noise when it strikes another object. . . . WHERE TO SHAKE OUT A DUST MOP is a problem solved by Sherman F. Wells, of Minneapolis, Minn., in a design for a new type of vacuum cleaner. A built-in mop-cleaning receptacle forms the top of the dust bag, but does not communicate directly with it. Instead, a tube from the receptacle leads through the dust bag to the intake of the blower, from which the dust is carried into the main body of the bag. A control at the front of the vacuum cleaner operates a valve so that air will be drawn at will either from the regular suction nozzle or from the mop-cleaning receptacle. . . . A CLEVER COMBINATION of a nut, lock washer, and bolt provides a fastening that no amount of vibration can work loose, in a design perfected by J. V. Uherkovich of



*(Continued on page 18)*


## Get Expert Advice on How to PROTECT And SELL YOUR INVENTION

You have an invention to protect. What are you going to do about it? Are you going to take steps right away to secure for yourself the protection provided by the U. S. Patent laws? Or are you going to let things slide, to hope that no one will discover the same thing and Patent it before you "get around to it?" If so, you may wake up some morning and find that someone has already Patented an invention similar to yours—and you are too late!

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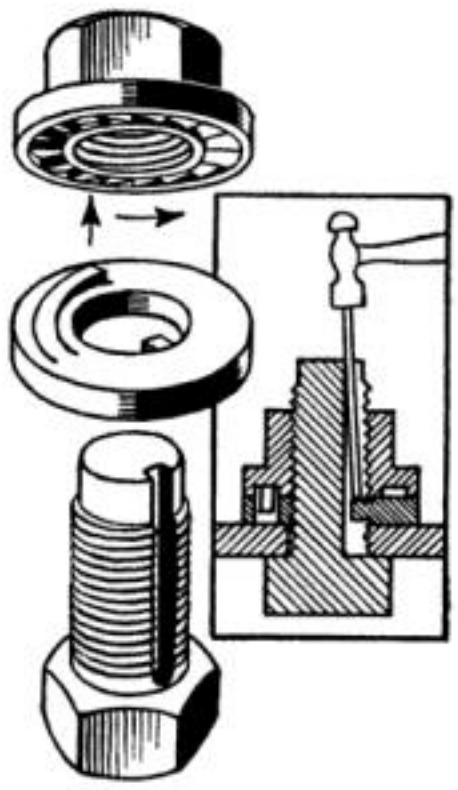
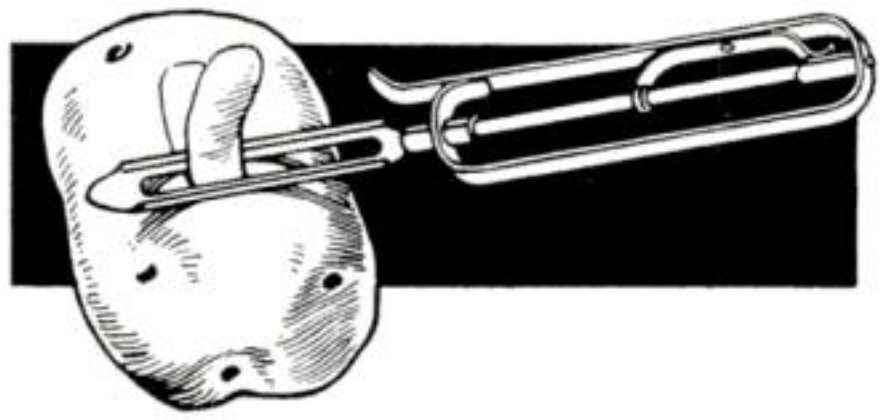
# With the Inventors

*(Continued from page 16)*

Gary, Ind. When the washer is slipped over the protruding end of the bolt, an internal key on the washer enters a channel in the bolt, so that the washer cannot turn. Screwing home the nut, in turn, engages sunken ratchet teeth on its face with a springy pawl of the washer, so that it is physically impossible to unscrew the nut again without breakage. If removal of the nut should ever be necessary, a slender tool may be slipped down the channel of the bolt and used to shear off the washer key. The nut and washer may then be turned together until the nut is freed, the broken washer being discarded. . . . BY ROTATING WITHIN ITS HANDLE, the blade of a new kitchen tool automatically follows an irregular surface to peel fruits and vegetables, including potatoes. An oval cut-out in the blade provides the cutting edge, which is so arranged that it neither digs far into the vegetable nor skids over the surface, according to the inventor, Ferdinand E. Fender of Evanston, Ill. The action of a flat, light spring in the handle keeps it in position to engage the surface at a touch. As a safety feature, the outer edge is not sharpened, except for the point, which serves to dig out eyes and bad spots. A handle extension provides a convenient finger rest for the tool, which may be drawn toward or away from the user for peeling and shredding respectively. . . . AFTER BUYING A BICYCLE for his daughter Joan, Clyde R. Kutil of Sioux City, Iowa, discovered she would be unable to ride it safely for a





*(Continued on page 20)*

# A frank man-to-man talk about PATENTS—INVENTIONS AND SELLING INVENTIONS

The world of invention moves on. Yet about fifty years ago, some people were saying, "Well, there isn't much left to invent." Today we know that is one of the funniest things ever said. Just think what has happened in the last fifty years! Autos, radios, airplanes and thousands of useful, practical devices for home, shop and office have been put on the market. Inventors are constantly making the world a better place to live in.

Interesting examples: Hans Wach, an obscure worker, invented a simple device to utilize exhaust steam on ships. A report states that *already steamship lines have saved more than $15,000,000 on fuel bills with his invention.* The Department of Commerce has announced that it will test out a new airplane. The inventor states that the average man can learn to fly in a day; that it will travel at the rate of 110 miles an hour and will sell at the price of a cheap automobile. Seattle man invented a robot to go 5,000 feet under the sea and recover millions and millions of dollars worth of gold lying at the bottom of the ocean since the days of the early Spaniards.

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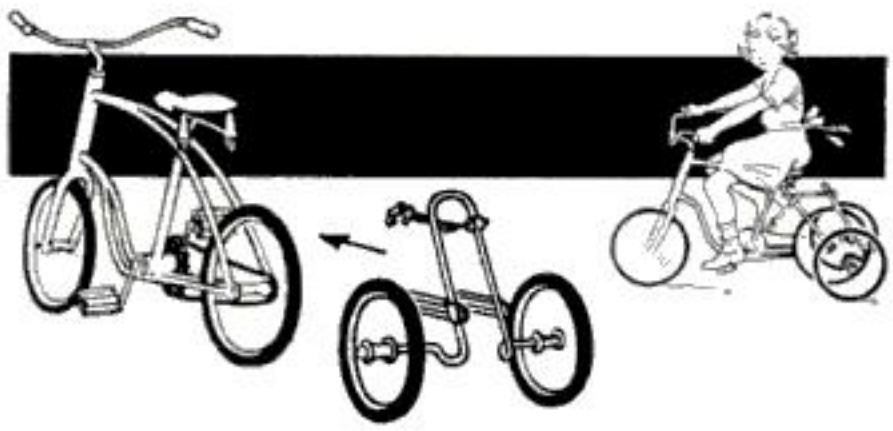
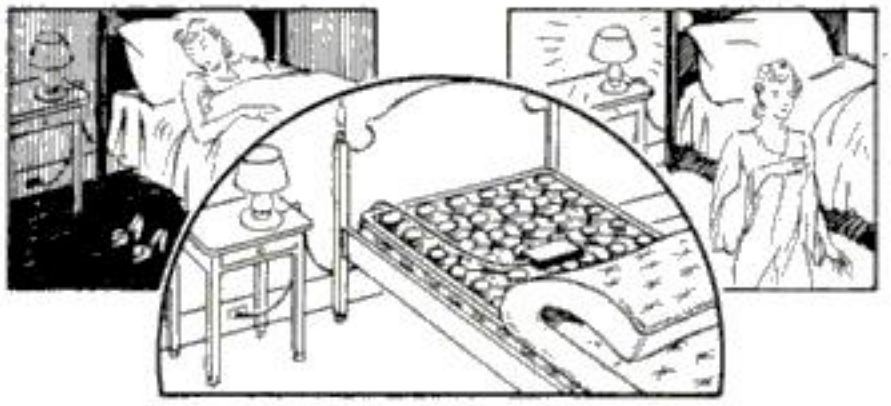
# With the Inventors

*(Continued from page 18)*

year or more. Instead of storing the bike away, he contrived an attachment that temporarily converted it to a velocipede, and the idea worked so well that he patented it. The rear wheel of the bicycle still serves as the driving wheel; while a pair



of extra wheels, coupled on through an ingenious spring mounting, make it virtually impossible for a youthful rider to tip over. This attachment need be manufactured in only two models, according to the inventor, to fit all bicycles from juvenile to adult size. . . . THERE IS NO RULE compelling a patent seeker to hire an attorney. The Patent Office is open to any inventor, and he can inspect for himself all its records of patents granted. But the Office strongly advises employing a competent patent attorney registered with it, whose specialized training will enable him to prepare a skillful specification and air-tight claims. . . . STEP OUT OF YOUR BED, in the middle of the night—and the light automatically goes on. There's no danger of tipping over a bedside lamp, or stumbling over shoes and chairs on the way to a wall fixture, with an automatic night light devised by Roy Ketchum of Philadelphia, Pa. Its secret lies in a compact switch, placed between the mattress and bed spring, which is operated by the



weight of the sleeper. When he retires once more, the self-acting switch turns the light off again. . . . FISH TRAVEL AGAINST THE CURRENT—when it's electric current. This remarkable discovery lies behind a U. S. patent for "Electrolytic Fishing" just

*(Continued on page 22)*

# INVENTORS

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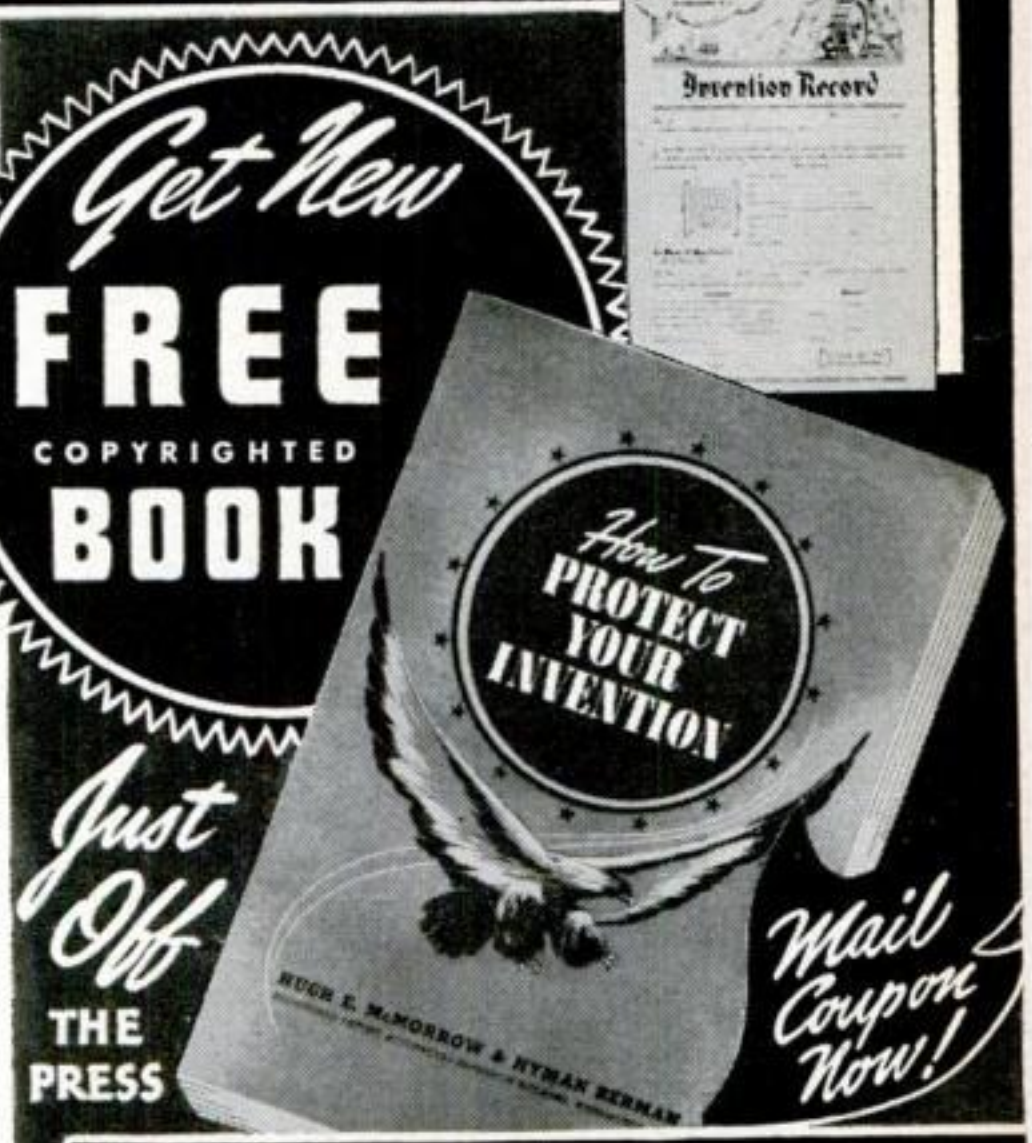


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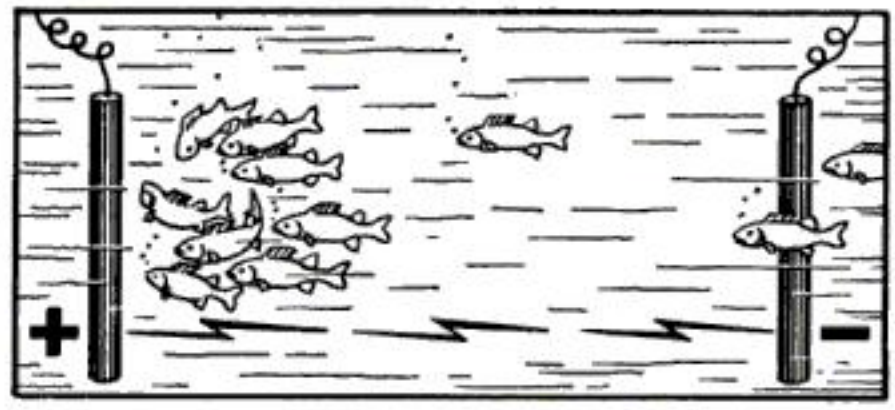
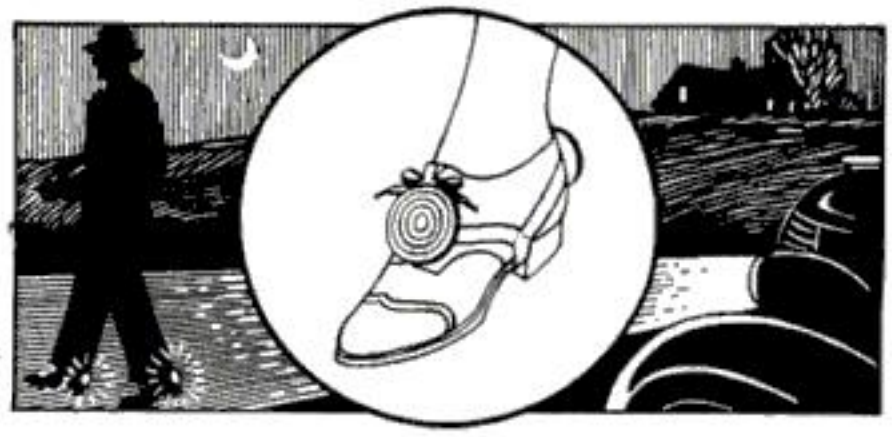
# With the Inventors

*(Continued from page 20)*

granted to Ramon Gomez of Halifax, Nova Scotia. Experiments have shown, he says, that sardines and herring will swim away from a negative electrode and toward a positive electrode, when both are immersed in sea water. All that is needed is an elec-




tric generator capable of supplying the graphite electrodes with the necessary power. For a distance of 325 to 500 feet between anodes and cathodes, 20 kilowatts suffice. When a string of positive electrodes is arranged at the inner end of a bay, and a string of negative electrodes placed across its entrance, fish in the bay are as securely "bolted in" as if nets closed every avenue of escape. They may be caught, as they cluster about the anodes, either by conventional means or with electrified traps applying the same principle as the large-scale installation. . . . A SET OF REFLECTOR BUTTONS for footwear, invented by Ruth R. McKinley, of Miami, Fla., may be attached and removed so easily that they should save lives and injuries among campers and hikers. Snapped on a shoe in a jiffy, an elastic harness bears light-reflecting buttons at front and rear. When the wearer goes down a road after dark, headlight rays of an oncoming car transform him into a walking danger signal—a boon to the



nerves of pedestrians and drivers alike. When the user arrives at his destination, he slips the safety attachments off his shoes, and drops them in a pocket for future use. The simplicity of the design is said to make possible a low manufacturing cost and selling price.

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QUALITY developing — prompt service. Rolls developed two prints each negative, free enlargement coupon, 25c. Postcard brings mailer. Petyt Studios, Dept. 11-G, 3310 W. 65th St., Chicago.

36 EXPOSURE 35MM roll developed, Vaporated, enlarged to 3x4, $1.00! Send rolls or write for Free book, "Secrets of Shooting Better Pictures". Superlabs, Box 500-S, Elroy, Wisc.

18 SPARKLING Lifetone Prints, 3 Hollywood enlargement coupon (Ivory frames free) each roll 25c. Finished 3 hours. 18 reprints 25c; 75—$1.00. Overnight Studio, 81 Cherry, Albany, Wis.

ROLL developed and 8 beautiful enlargements 2 to 6 times larger—deckled edge—high gloss. Any 8 exposure roll 25c coin. Reprint enlargements 3c each. Alden Photos, 258-C Astor Station, Boston, Mass.

ROLLS developed and 4x6 oversize glossy Velox prints 8 exposure 25c. 12 exposure 35c. 16 exposure 50c. Overnight service. Clemet Photo Service, 1318 W. Columbia Ave., Philadelphia, Pa.

ROLLS developed. Two sets prints plus enlargement coupon, 25c. Reprints, 3c. Over 19 reprints, 2½c. Jones Studios, Davenport, Iowa. "Where the West Begins."

ROLLS developed, two prints each and two free enlargement coupons, 25c; reprints, 2c each; 100 or more, 1c. Summers' Studio, Unionville, Mo.

IDEAL Photos beautifully finished wide border deckle edge, 25c, roll of 8 and free enlargement. Ideal Photos, Box 2255, Paterson, N. J.

TWO beautiful prints from each picture on roll 25c. Twenty years of satisfied customers. Quick Service. Lens Photos, Dept. J-9, Janesville, Wis.

ROLLS developed — 25c coin. Two 5x7 double weight professional enlargements, 8 gloss deckle edge prints. Club Photo Service, Dept. 21, LaCrosse, Wis.

SIXTEEN Prints from each roll developed, or eight prints and Two enlargements, 25c. Prompt and dependable. Globe Photo Service, La Crosse, Wis.

LOOK! Get sixteen prints per roll 25c, plus valuable coupon on 3-4x6, 2-5x7, or 1-8x10 enlargement. Modern Studios, LaCrosse, Wis.

ROLL developed and printed 6 and 8 exposure including 5x7 enlargement 25c coin. Gem Photo Service, Dept. A, 3338 W. 63rd, Chicago, Ill.

ARTISTIC Finishing! Get acquainted offer: rolls printed; 15c. 35mm enlarged: 85c. Free enlargements and coupons. Box 12, Kingsbridge Sta., New York City.

16 OVERSIZE Deckledged prints and two enlargements, 25c. Owlphoto PS2, Weatherford, Okla.

ROLL developed, eight beautiful professional 4x6 gloss enlargements; 25c. Crystal Studios, Box 159 S. Rushford, Minn.

ROLL Developed—16 guaranteed prints, two coupons on enlargements, 25c. Smart Photo, Winona, Minn.

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BEAUTIFUL enlargement from each picture on roll 25c. Cut Rate Photos, Dept. A-6, Janesville, Wis.

ROLL developed, 16 guaranteed prints, 25c, reprints 2c. Photolab, 1806-P Wabash, Chicago.

ENLARGEMENTS that Please, 5x7, 3 for 25c, and 8x10, 3 for 50c. Send negatives. Lee Photos, P. O. Box 2053, Chicago.

ROLL, developed, printed 15c. Reprints 1c. Howards, 833 Roscoe, Chicago.

5x7 ENLARGEMENTS 10c. Three for 25c. Winehold Photo, Woodbine, Pa.

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100 LETTERHEADS, 100 Envelopes; both $1.00 postpaid. Hammermill $1.25. Benneville, 907 W. Roosevelt, Philadelphia.

PRINTING Small or large quantities at quantity price. Samples, price-list. Sicocan, 2038 Obear, St. Louis.

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$5000 FROM Half Acre! Growing "Ginseng" Seed, contract supplied. Fall planting. Particulars 10c. Associated Growers, Dept. 12, St. Norbert, Manitoba.

BIG money raising Angora Wool Rabbits! Wool brings $5 lb.! Easy, fascinating. Illustrated catalogue, wool samples, 10c. Clay Rabbit Farms, Spokane, Wash.

$40.00 WEEKLY, made growing mushrooms for us, fresh, dried. Dominion Patent 331583, free spawn. North American, 169Y Yonge, Toronto, Canada.

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RADIO engineering, broadcasting, aviation and police radio, servicing, marine and Morse telegraphy taught thoroughly. All expenses low. Catalog free. Dodge's Institute, Poplar St., Valparaiso, Ind.

NEW or Used Amplifers for sale. Guy Fleming, Huntsville, Mo.

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FREE! Foreign Coin, banknote and large 36 page illustrated coin catalogue to approval service applicants. Send 3c postage. Up to $20 cash paid for Indian head cents. All dates wanted. Buying list 10c. Tatham Coinco, Springfield-D50, Mass.

CERTAIN Cents worth $750.00. Biggest value coin book published. 1941 Edition. 36 pages illustrated with actual photographs. Special price 10c. American Coins, Box 3507-C, Cleveland, Ohio.

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COMMEMORATIVE $½s. Columbian, Lincoln, Stone-Mountain, Long-Island, Cleveland, $1.00 each. Illustrated catalogue 25c. Norm Shultz, Salt Lake, Utah.

ILLUSTRATED retail coin catalogue 10c (refunded). 3000 Quotations. James Randall, 341 So. Dearborn, Chicago.

WE purchase all Indianhead pennies. Purchasing catalogue 10c. Greenwood, 398 Broadway, New York.

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CUSHIONED, 2 lines 25c, 3—35c. Ours are better! Ad-Crafts, LaCrosse, Wis.

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SONGS & Song Poems Wanted. No Charge for melodies. Free examination. Hollywood Recording Studios, 87L9 Preuss Sta., Los Angeles.

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SONGWRITERS. Write for free booklet, profit sharing plan. Allied Music Company, 7608 Reading, Cincinnati, Ohio.

SONGWRITERS — Write for Free Book, Plans, Information. Variety, Dept. 9, Salem, Ind.

SONGWRITERS: Send poem for our plan and Free Rhyming Dictionary. Richard Brothers, 146 Woods Bldg., Chicago.

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SONGWRITERS' opportunity—Free booklet, plan. Song Service, 43-J Park Place, Brooklyn, N. Y.

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WITH a "Blue Line" Recoil Pad on your gun you'll have no blue line on your shoulder. Write for free catalog. Mershon Company, Inc., Glendale, Calif., Dept. B.

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WHEN Trekking is Hard, use a light, fine quality, "Trek" tent. Write for free catalog, Mershon Company, Inc., Glendale, Calif., Dept. B.

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FISHERMEN—Make your own sinkers. Free folder. Reading Instrument Co., Box 78, Reading, Pa.

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**NOTICE**

Readers answering ads offering *Approvals* receive a selection of stamps from which they may make purchases at prices indicated. Ten days are allowed for payment and return of undesired stamps. Otherwise approval applicants become subject to Section 2350, Postal Laws & Regulations, 1932, providing penalties for obtaining property by false pretense.

GIANT Packet 136 All Different from Africa, South America, South Sea Islands, etc. Includes Nicaragua airmail, two scarce unused United States cataloging 20c, triangle and animal stamps; many others. Also includes fine collection 25 different British Colonies—Charkari, Jamaica, Johore, etc. and United States $4 and $5 high values. Total catalog price over $4.00! Everything for only 5c to approval applicants! Mystic Stamp Co., Dept. 55-A, Camden, New York.

SUPER-Wonder Packet offered containing stamps from Afghanistan (oblong), Transjordania (emir), North Borneo (buffalo), Manchukuo (Mausoleum), Sudan (native), Sarawak (rajah), Guadeloupe (sugar refining), Costa Rica (triangle), Iraq (late king), Brunei (boating); this entire packet for only 5c to approval applicants. Big illustrated lists free. Kent Stamp Co., G.P.O. Box 87 (24), Brooklyn, N. Y.

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25 OLD U. S. 5c to approval applicants. Livings, 2811 Lemmon, Dallas, Texas.

POSITIVELY Greatest Free Offer—latest Scott's International $3.50 Stamp Album—covering entire World, contains 34,000 illustrated, descriptive spaces: Scott's 1942 Standard $3.00 Catalogue "Philately's Encyclopedia"—both absolutely free to applicants for Foreign Approvals becoming customers! Plymouth, Dept. B3, Bell, Calif.

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MAURITIUS; Bermuda; Hyderabad; Sudan; Patiala; Travancore; Selangor; Jamaica; Barbados; Eritrea; Philippines; Perak; Slovenia; Haiti; Luxemburg; 5c with approvals. Stamp Service, 53-C Webster Ave., Brooklyn, N. Y.

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FINE Approvals, freshly mounted. Fast, personal service. Tell me what countries you prefer and I will send their stamps. Milton Skinner, 306 East Fourth, Long Beach, Calif.

STAMP Dealers—Your ad in this column will produce profitable business at low cost. Write for proof. O. K. Kelly, Dept. S-1, 353 Fourth Ave., New York, N. Y.

UNITED States approvals complete coverage fine quality, attractive prices. Seminole Stamps, Box 536, Coconut Grove, Florida.

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WHOLESALE Supplements to dealers for 10c postage. Hundreds of bargains. Grossman Stampco, 102-S W. 42nd, New York.

1000 U. S., Commemoratives, etc., 25c; finest U. S. Mission Mixture Sealed Bags, 5 pounds $2.00. Borkman, 256-P Seaman, N. Y. C.

25 DIFFERENT U. S. including $4 & $5 stamps to new approval applicants sending 3c postage. Brownie Stampshop, Dept. P, Flint, Mich.

50 U. S. including commemoratives, airmails, perfgauge, approvals 10c. Stamp Shop, 813 Hollandbldg., St. Louis, Mo.

$10 UNITED States Stamp and Illustrated Brochure Canada Stamps .03. Peterson, Box 31, St. Paul, Minn.

140 CYPRUS, Jaipur, Congo, Tunis, Mozambique, Mauritania, etc., 10c, Lufbery, Middletown, Conn.

FREE! Canada Royal Visit complete with approvals. Chester, Box 545-V, Utica, N. Y.

FREE! Western Hemisphere Packet. Postage 3c. Owens, 801 Welshbldg., Baycity, Mich.

FREE—14 different $1.00 stamps, bargain lists, approvals, 5c postage. Humphrey, 310S Cloverleaf, San Antonio, Texas.

EXCHANGE your duplicate stamps. List, swappers, dime. Registrar, Box 2166, Denver, Colorado.

FREE—Five beautiful Airmails, including Triangle, to approval applicants. Green and Co., Norwood, Ohio.

FREE! Pony Express set (facsimiles). Postage 3c. Roberts, 401 Shearerbldg., Baycity, Mich.

2c BUYS seven varieties large Algiers, Paraguay set, triangles, etc. Approvals. F-S Co., Box 2154, Houston, Texas.

UNITED States Commemoratives—100 different, 65c: 500 mixed $1.10: 1000, $1.95. N. Barcus, 3787 Longfellow, Detroit.

100 U. S. including complete ½c—$5.00 set only 15c. Matz-5, Carmi, Ill.

PENNY Approvals that satisfy. Neil Gromberg, Box 5441S, Philadelphia, Penn.

FREE! Austria War set. Postage 3c. Williams, 601 Archerbldg., Baycity, Mich.

20 MEXICO, 3c, with approvals ¼c up. Josip Babcock, St. Joseph, Mich.

FREE! Bavarian Railway set, 14 varieties, postage 3c. Benters', Burke, S. Dak.

SOUTH American—100 different 10c—with approvals. Davis, Silver Lake, Ind.

100 ALL Different U. S. 10c. Monjar, 1542 Waverly, Cincinnati, Ohio.

500 MIXED Foreign, U. S. only 10c. Approvals. Macek, Madison, Ill.

100 UNITED States stamps before 1919, 25c. Taetsch, Westville, Conn.

DISCOUNTS from our net approvals. Hobby, Box 21P, Rosebank, N. Y.

## TATTOOING SUPPLIES

TATTOOING—Engraving, greater demand. Illustrated list. Percy Waters, Anniston, Ala.

START profitable tattooing and removing business. Free instructions. Write Tattooco, 651 S. State, Chicago.

## TOBACCO

PAY when received good red leaf chewing or smoking, 15 lbs. $1.00. Prompt shipment. Jim Ray, Ralston, Tenn.

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MT-SCOPE Metal Locator fully guaranteed and unsurpassed in efficiency. Time payment plan, trade-in and accessories. Free literature. Fisher Research Laboratory, Palo Alto, Calif.

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TYPEWRITERS, adder, mimeograph, multigraph, addressograph. Send for free lists of machines that will help you at half price. Pruitt, 23 Pruitt Bldg., Chicago.

ROTARY Duplicators $9.95. Stencils $1.00 dozen. Professional Products, 856, Cincinnati.

## WANTED—MISCELLANEOUS

CASH for used Microscopes, Drawing Sets, Binoculars, Slide Rules, Watches, Scientific and Medical Instruments, Tools. Satisfaction guaranteed. Elman's, 105-SH S. Wells, Chicago.

HIGHEST Prices for used Cameras, Binoculars, Microscopes, Drawing Sets, Tools, Rifles, Shot Guns, any optical or scientific Instrument. Satisfaction guaranteed. Gordon's, 162-S Madison, Chicago.

MERCURY. Cash paid promptly. Quotations free. Mercury Terminal, Norwood, Mass.

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WATCHMAKERS' Materials—Tools—Watches. Bought; Sold. Best prices for Old Gold, diamonds. Free Catalog. Ben Segal Company, Box 150, Chicago.

ELGIN, Waltham Watches $3.50. Make big money. Free watch and jewelry catalog. Plymouth Jewelry Co., 163-B Canal St., N. Y.

WATCHMAKERS' Tools, supplies, Watch parts. Write for price list 50. Dean Co., 116 Nassau St., New York.

## WELDING, SOLDERING

BARGAINS. Demonstrator arc welders, gasoline and electric drive. Build your own portable, save $500. Liberal Trial. Easy terms. Write Hobart Welder Exchange, Box P-812, Troy, Ohio.

D. C. Arc-Welder. Build it yourself from Automobile generators, vehicle motors, light plant generators. Plans $1.00 each. Welders Club, WB-3432 M-Mart, Chicago. For Sale: Vehicle motors, Welding Supplies.

BUILD 60-200 Amp. A-C welder for $10. Several plans $1.00. Information dime. Hi-Point Electric Products, Dept. P, Bellefontaine, Ohio.

110-220 VOLT arc welders, helmets, plans, material. Holgerson, Canton, Kansas.

# WONDERS OF AMERICA

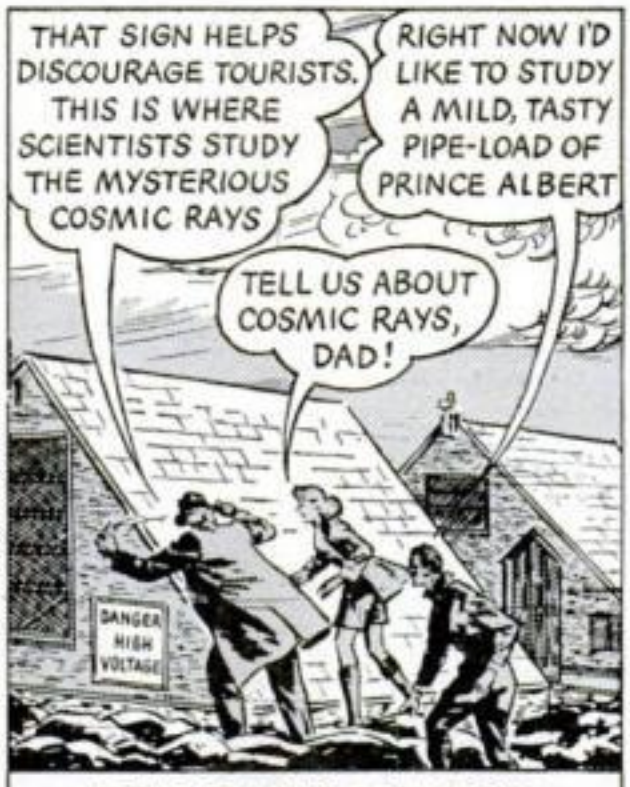
## Most Powerful Force on Earth!

ON MT. EVANS, COLORADO, NEAR DENVER

IN RECENT LABORATORY "SMOKING BOWL" TESTS, *PRINCE ALBERT* BURNED

**86 DEGREES COOLER**

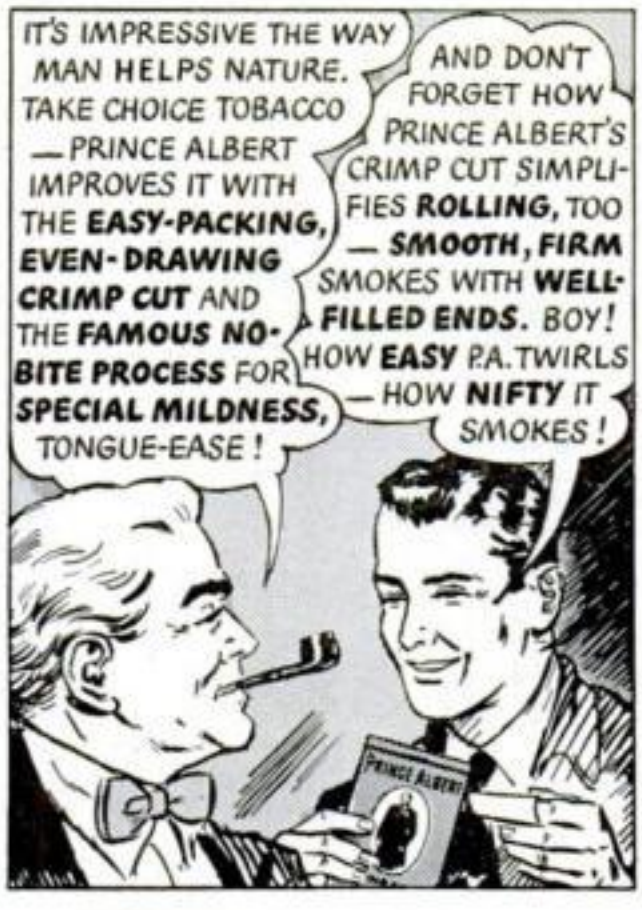
THAN THE AVERAGE OF THE 30 OTHER OF THE LARGEST-SELLING BRANDS TESTED— *COOLEST OF ALL!*



AT THE FAMOUS COSMIC RAY LABORATORY OF DENVER UNIVERSITY

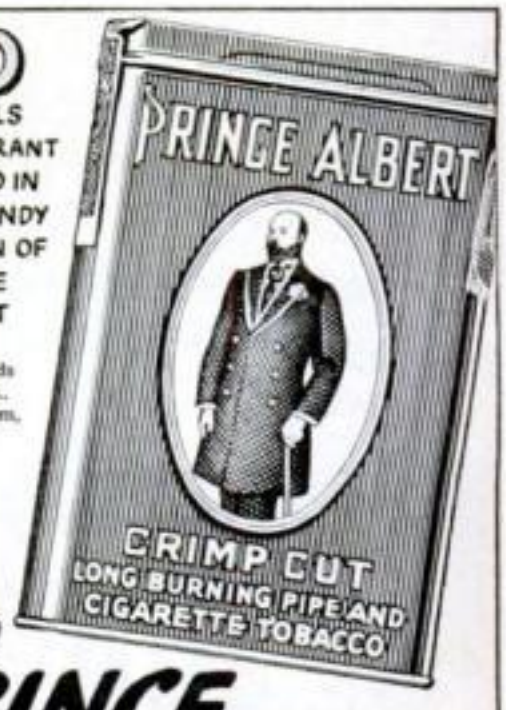

SCIENCE THINKS THAT THE SPECTACULAR COSMIC RAYS WHICH SHOWER THE EARTH DESCEND FROM THE GREAT OUTER SPACES. THE RAYS, MOST POWERFUL KNOWN FORCE ON EARTH, ARE 5 TIMES STRONGER ATOP MT. EVANS THAN AT SEA-LEVEL. LIGHTNING STRIKING MT. EVANS BATHES PEOPLE AND OBJECTS IN A GHOSTLY GLOW

THIS AMAZING DEVICE ABOVE TELLS WHICH WAY THE COSMIC RAYS ARE COMING, AND COUNTS THEM TOO!



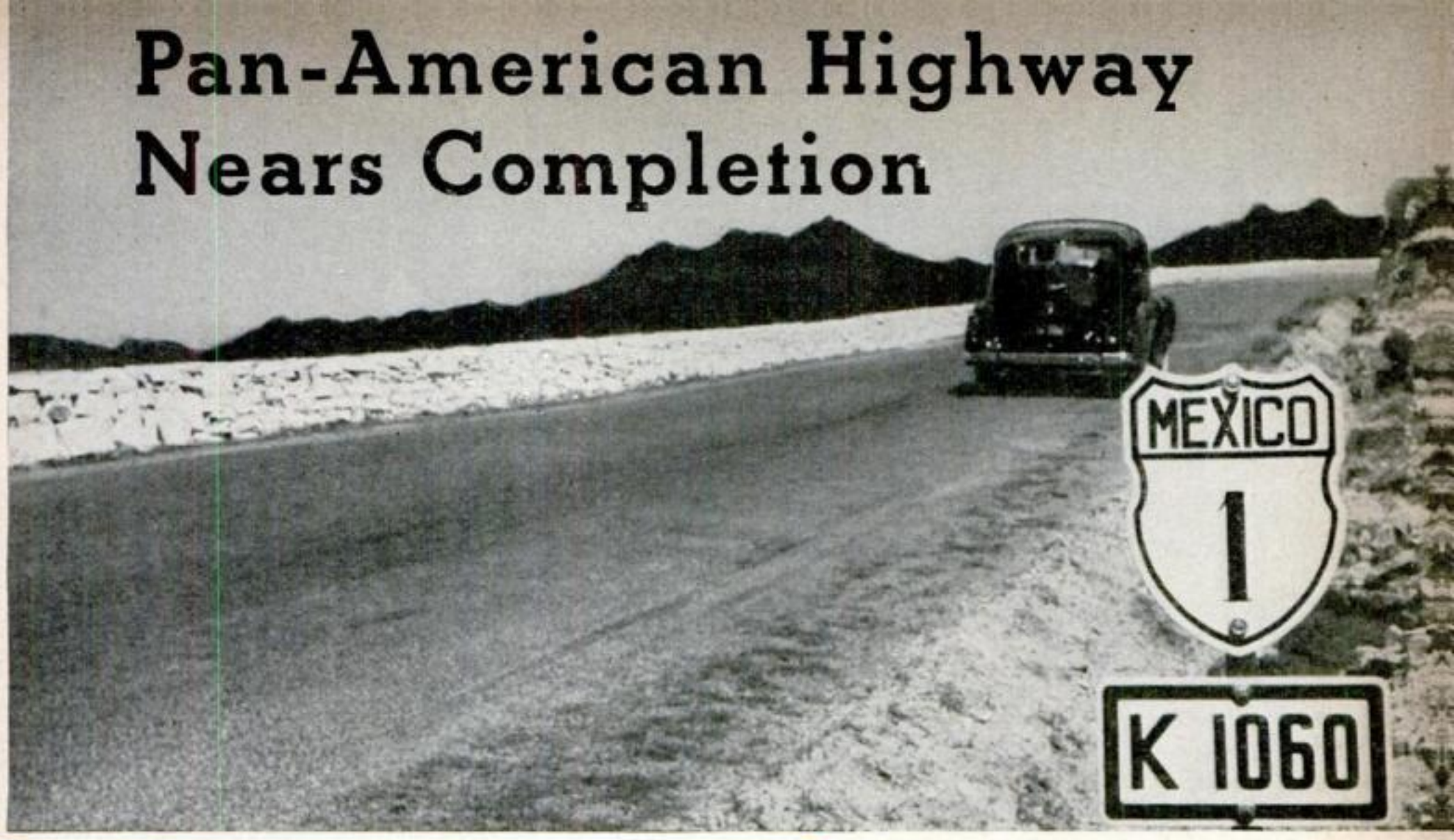

**50** PIPEFULS OF FRAGRANT TOBACCO IN EVERY HANDY POCKET TIN OF PRINCE ALBERT

R. J. Reynolds Tobacco Co., Winston-Salem, N. C.

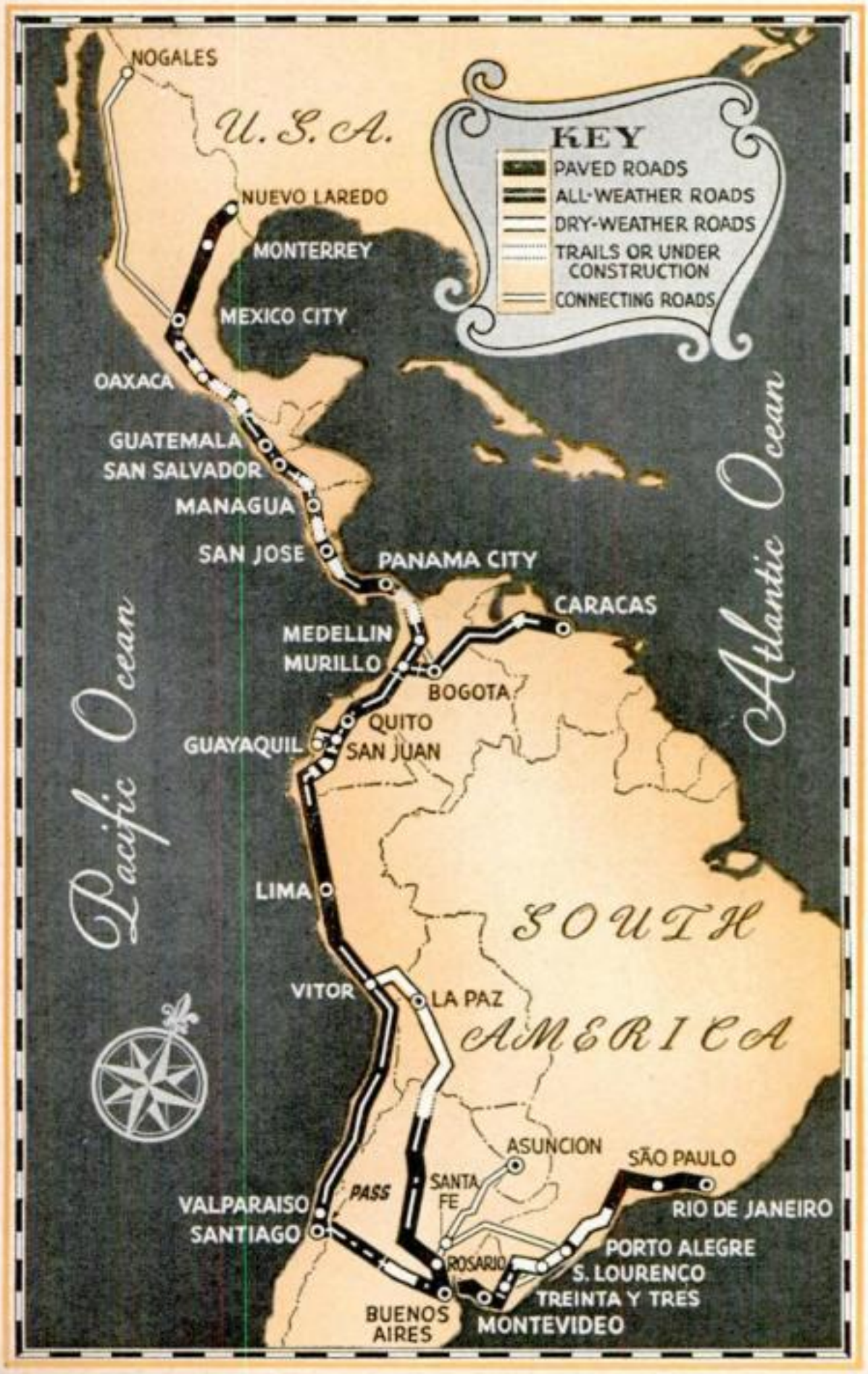



**PRINCE ALBERT** THE NATIONAL JOY SMOKE

# Pan-American Highway Nears Completion




Clouds contest the right of way along this 9,000-foot-high stretch of the road from the Texas-Mexico border to Buenos Aires




THE PAN-AMERICAN highway is now passable most of the way from Laredo, Texas, to Buenos Aires and Rio de Janeiro, and the 18-year-old dream of a motor road from Fairbanks, Alaska, to the Straits of Magellan may actually come true by October 12, 1942, the 450th anniversary of Columbus's discovery of America. This has long been the builders' goal, but until recently it seemed impossible to meet.

A 300-mile stretch through the jungle of the Darien Peninsula had not even been surveyed and jungles and jagged peaks in Southern Mexico, Costa Rica, and Ecuador made the building too expensive for the treasuries of all the countries concerned except Mexico. Similarly, the high cost of blasting through the Rockies has held Canada back. Then, because of the importance of the road to hemisphere defense, the United States began lending money, to Nicaragua, to Costa Rica, to Panama, to Ecuador, to Paraguay, and President Roosevelt asked Congress for $20,000,000 with which to help finish the highway through Central America to the Panama Canal. The United

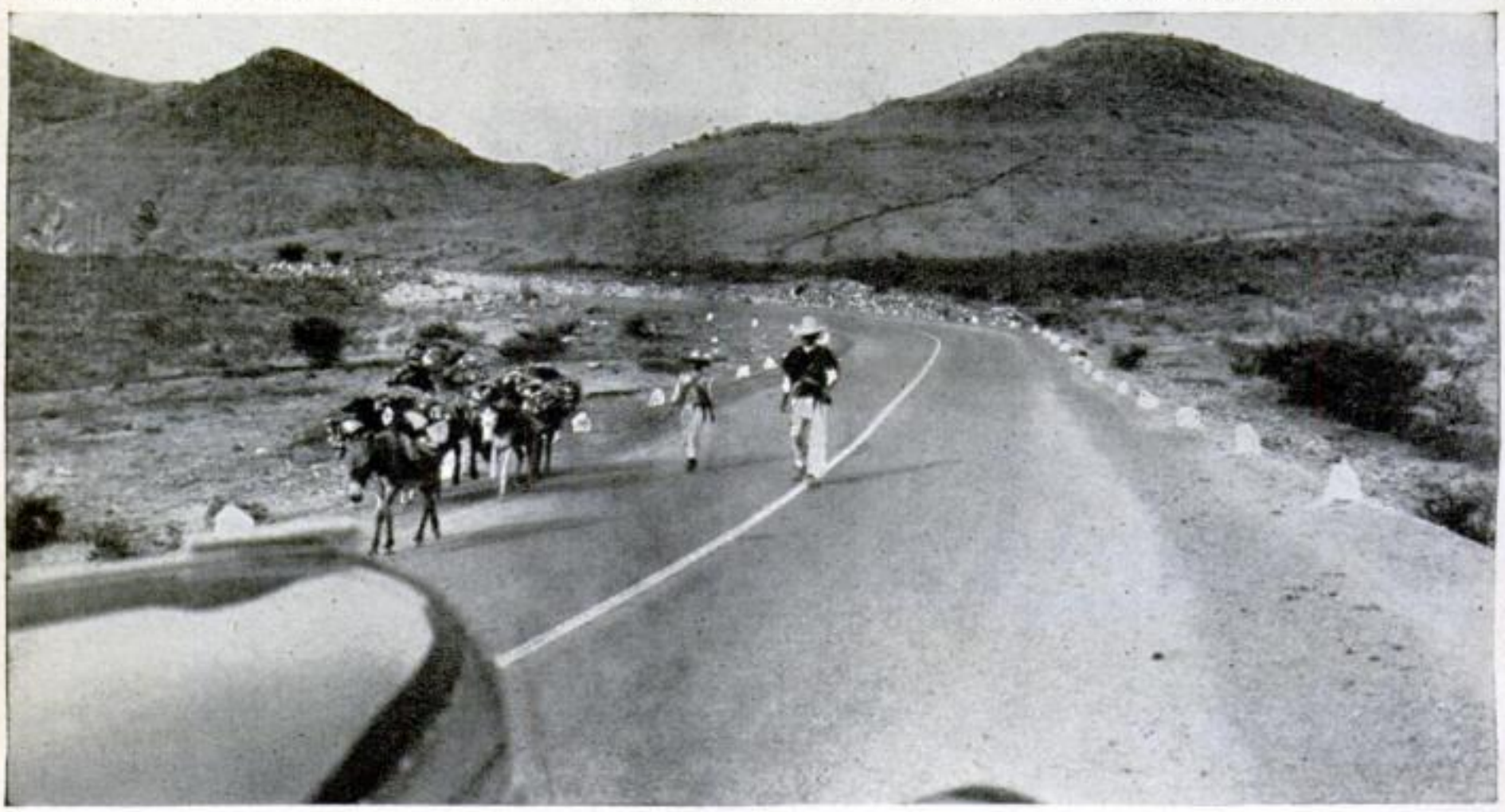
A motorist examines a road of hand-laid stones built by Cortes as a car whizzes by on the new highway

States is also expected to advance money to build the road through Canada to Alaska.

There is still talk of the Central American part requiring five years to build and the Canadian section from three to fifteen years, but there are close students of the project who say the road can be completed in a year, if necessary. The trade of the United States with Latin America amounted to more than half that with Europe in 1939, the last year for which figures are available, and it is conceivable that if this country has to fight a two-ocean war the Pan-American Highway will become the Americas' Burma Road.

In South America, 96 percent of the way is passable in dry weather and 86 percent is either graveled or paved. For several years now it has been possible to drive from the Texas border to Oaxaca, 600 miles below Mexico City, although the road is paved for less than 200 miles south of the capital and from Huajuapan to Oaxaca it is impassable during the rainy season. Most of the thousand miles from Oaxaca to the Guatemalan border is still jungle, around

Streamlined autos and ambling burros meet often, for the peasants still live as they have for centuries



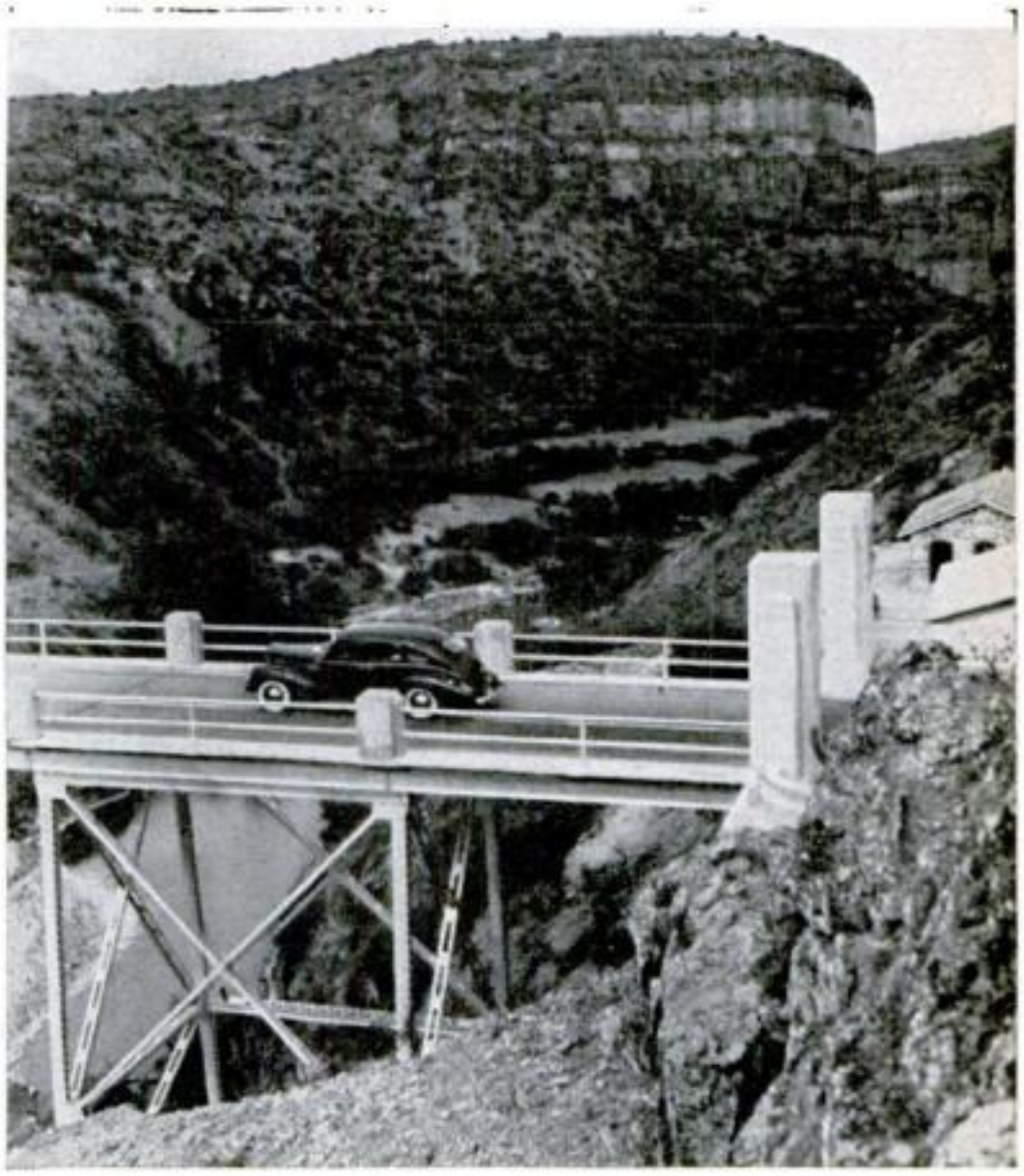
Cactus and hardy scrub are the only vegetation as you begin the climb up to the high table land on which Mexico City sits

which the traveler today must ship his car by train or boat, but the Mexican Government has already paved a fat portion of it.

The road is paved or graveled all the way through Guatemala and Salvador, in Honduras and Nicaragua it is largely passable in dry weather and Costa Rica has had from 500 to 4,000 men laboring on its share for nearly a year. In Panama all but a few miles is graveled or paved to a short distance beyond Panama City, but then comes that 300 miles of unsurveyed jungle of the Darien Peninsula. Cars must be shipped around this now, but it is possible to drive from a few miles on the other side of the Colombian border, or from Caracas, Venezuela, all the way to Argentina. The pass over the Andes on the road from Santiago is closed by snow from seven to nine months of the year, but the route through La Paz is open. From Buenos Aires to Rio de Janeiro half the road is paved.

South of Buenos Aires 1,918 miles of dry-weather road lead to the Straits of Magellan.—WALTER HOLBROOK.

Yankee-style steel bridges are rapidly replacing wooden ones. This one is over the Rio Tula, 100 miles north of the capital



# Frozen Motion

## TEACHES LAWS OF SCIENCE

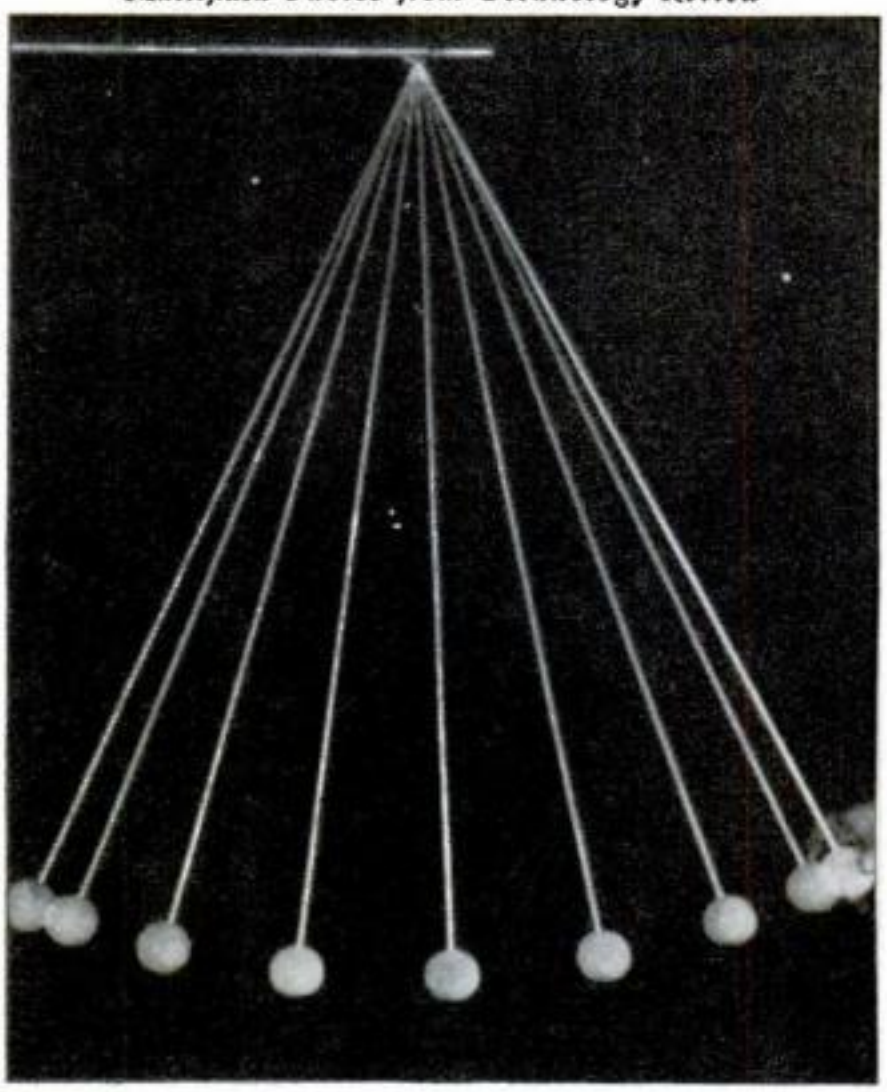
MULTIFLASH pictures that freeze successive steps of high-speed motion will be used this fall to demonstrate mechanical movements and teach fundamental laws of physics to first-year engineering students at the Massachusetts Institute of Technology, Cambridge, Mass.

In making the pictures, a battery of Edgerton lamps, giving off brilliant stabs of light at uniform, split-second intervals, record the positions of a moving object against a black velvet background. An ordinary 3¼ by 4¼-inch still camera, using cut film or film packs, is employed. To date, more than 50 different subjects, ranging from the swinging of a pendulum to the bouncing of a golf ball, have been filmed for classroom use.

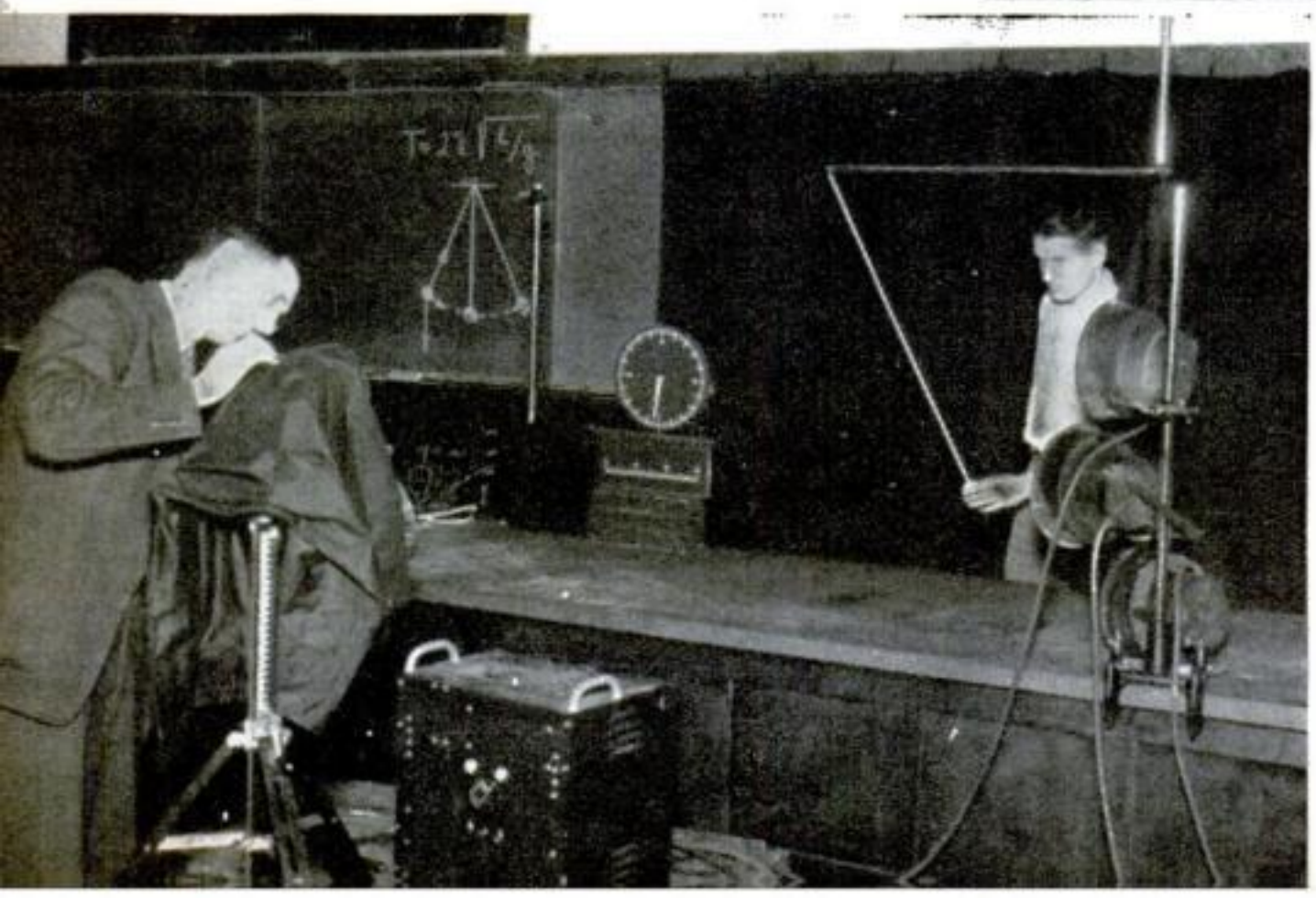
Employed as lantern slides, the pictures will enable students to analyze movements that are quicker than the eye. Because the whole motion, in successive steps, is shown in one picture which can be thrown on a screen at the front of a classroom and kept there as long as desired, the new technique in teaching is expected to prove more satisfactory than the use of high-speed motion pictures. Prof. Francis W. Sears and Prof. Harold E. Edgerton, inventor of the lamp which makes modern, ultra-speed photography possible, are responsible for the new development at the Cambridge institution.

When a distance scale and a clock face —with a hand that makes one revolution in two seconds—are incorporated in the pictures, they can be used as the basis for classroom problems as well as for visual education. The successive multiflash shots record the scale and the position of the clock hand as well as the position of the moving object in each exposure. Being given, in this way, the time interval and a gauge of the distance moved, the student can work out the exact velocity during any given phase of a movement.

*Multiflash Photos from Technology Review*



Simple harmonic motion is illustrated by multiflash photograph of a swinging pendulum. Highest speed is at center of the swing

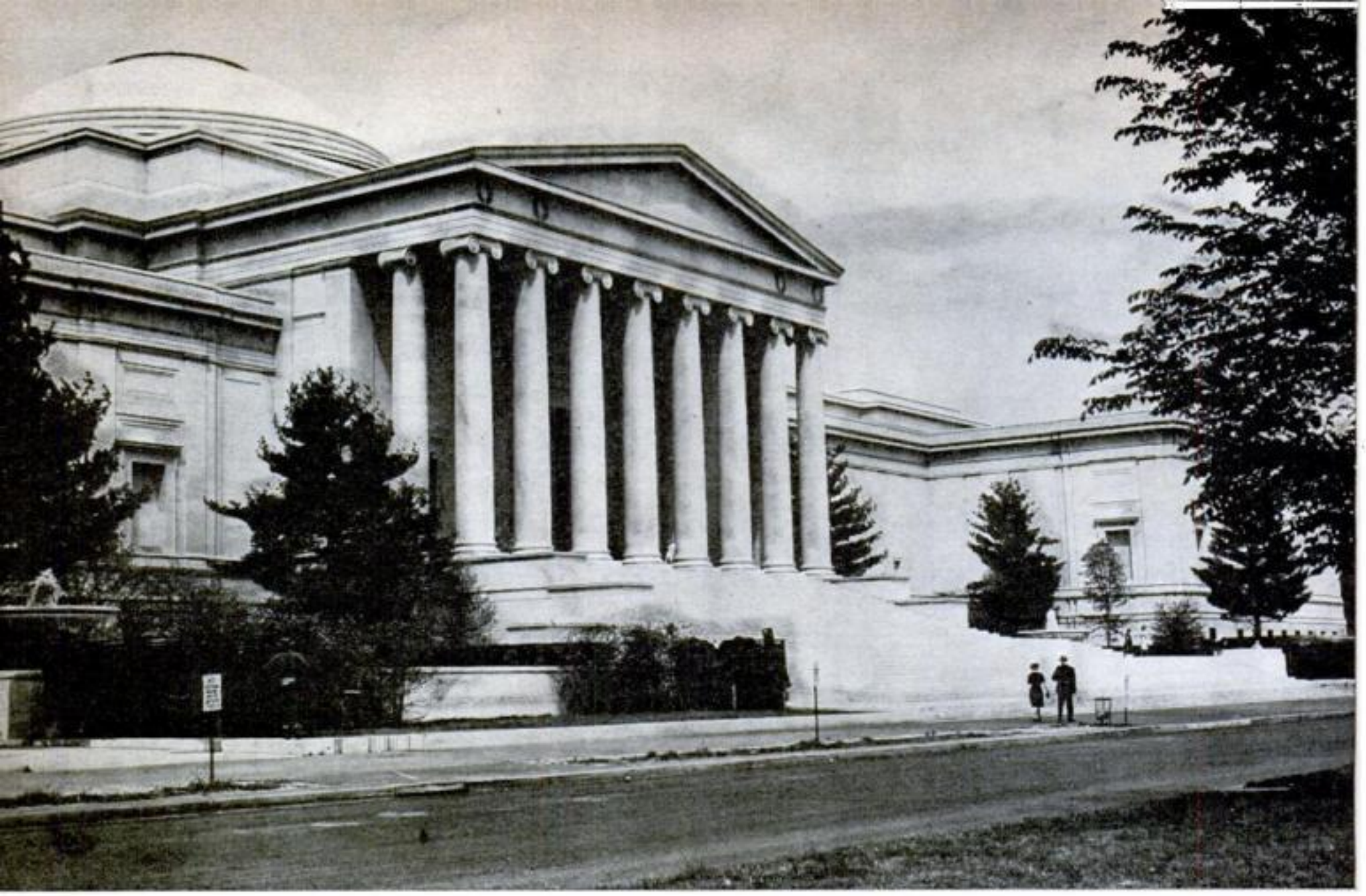


Prof. F. W. Sears preparing to photograph a pendulum. A clock dial and distance scale will appear in the pictures, enabling students to estimate the velocity at various stages

*POPULAR SCIENCE*

A bouncing golf ball. On each bounce, the ball gains velocity on the way down at the same rate that it lost it on the way up

How a rod flies through the air after being struck slightly below its center of gravity. Dark bands mark its top and center



The National Gallery of Art is a complex machine, designed to protect masterpieces through the ages

# Mechanized Treasure House

## NATIONAL GALLERY PROTECTS MASTERPIECES OF ART

By HENRY H. SAYLOR

THE CASUAL PASSER-BY will see the National Gallery of Art—Andrew Mellon's magnificent gift to the nation—merely as monumental architecture. It is really a complex and efficient machine. Behind that expanse of marble walls—longer, incidentally, than the Capitol itself—one will find not only one of the world's greatest collections of paintings and sculpture, but the last word in our scientific knowledge of building.

More than ten years ago, at the end of a day when Mr. Mellon left his desk as Secretary of the Treasury, he would often tell his chauffeur, "Just drive around." When he had found the site he wanted, he called in the architect, John Russell Pope, and his partners, Otto R. Eggers and Daniel P. Higgins; the engineer, H. G. Balcolm; the builder, Percy A. Vermilya. The problem he set before them must have seemed almost beyond accomplishment. The site was little better than a swamp, with no bedrock within reach for foundations. The land was no higher than the Potomac River's top flood level of 1932. The structure was to be built to endure for as long as American building genius could contrive. It was to present to the world a unified exterior, yet be capable of expansion sufficient to accommodate the art accessions of, say, two more centuries. In it were to be embodied the best fruits of our knowledge of lighting, air conditioning, and the protection of its priceless contents.

Lighting was a major problem. Experts said overhead daylight was the ideal. As a result the National Gallery's main floor is its top floor—a series of 90 exhibition rooms without side windows but with ceilings of a special diffusing glass, lighted by skylights and, when daylight fails, by floodlights. Thus acres of gallery roof are chiefly glass.

Below this main floor is one at street level, on which are located the administrative and work rooms, galleries for temporary exhibitions, a lecture hall, a cafeteria and its kitchen, receiving, repair, and photographic rooms. There is even a "de-

lousing" room for incoming works of art. Below this ground floor is most of the mechanical equipment.

Paintings are best viewed by diffused top light, but that is the worst light for sculpture. To see this three-dimensional art at its best, the light should be sharply directional, to give highlights and shadows. Moreover, the diffused top light for paintings must be equalized upon the four sides of a room, whatever the angle of the sun. That necessitated a considerable height between the ceiling glass—called "lay lights" —and the skylights, in places as much as forty feet.

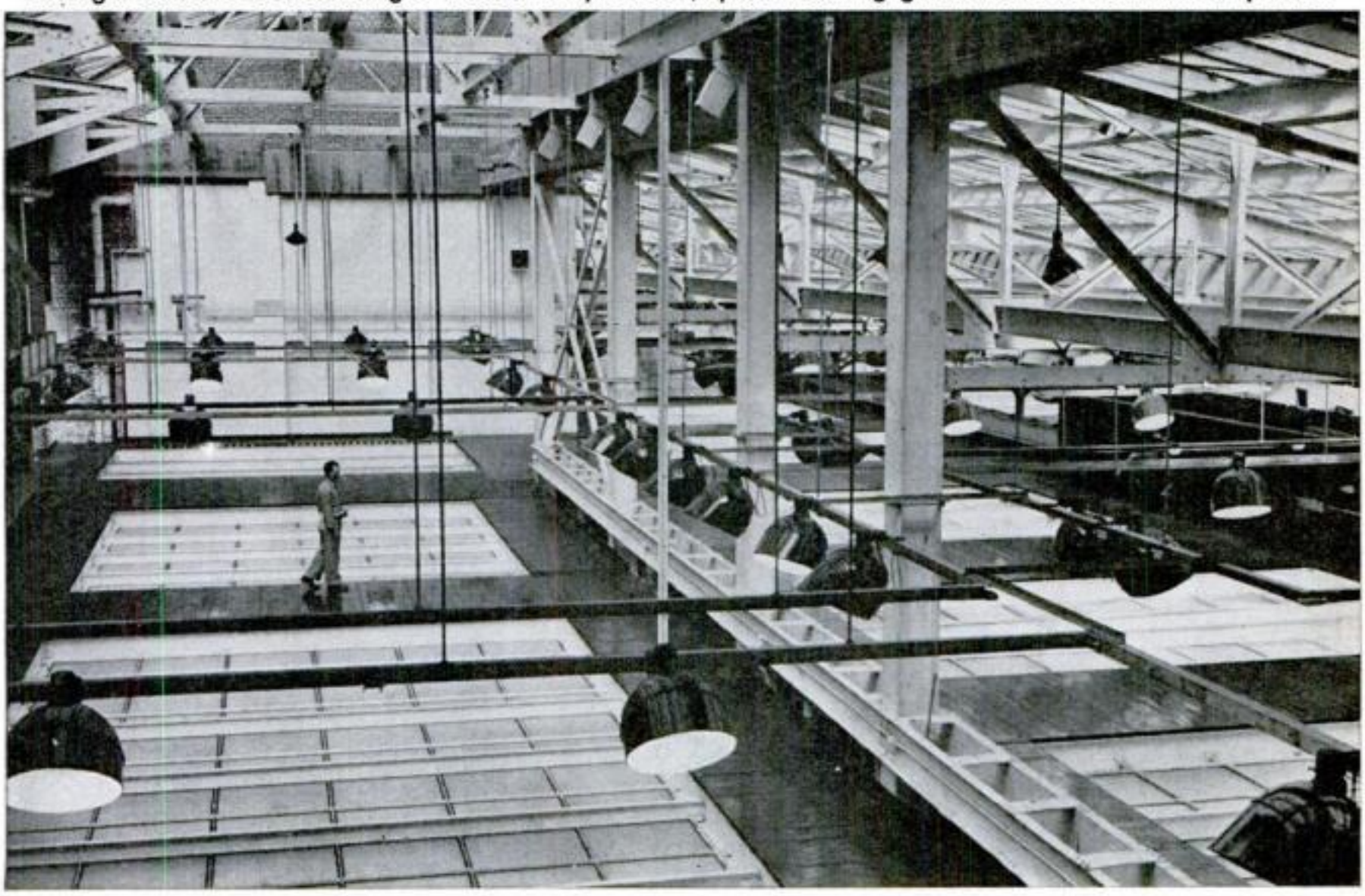
Directional light for the sculpture was achieved by using a border of lenses around the lay lights in each gallery. So flexible is this system that paintings and sculpture can be ideally lighted even when they alternate around the room. And of course the lighting can readily be changed to suit rearrangement.

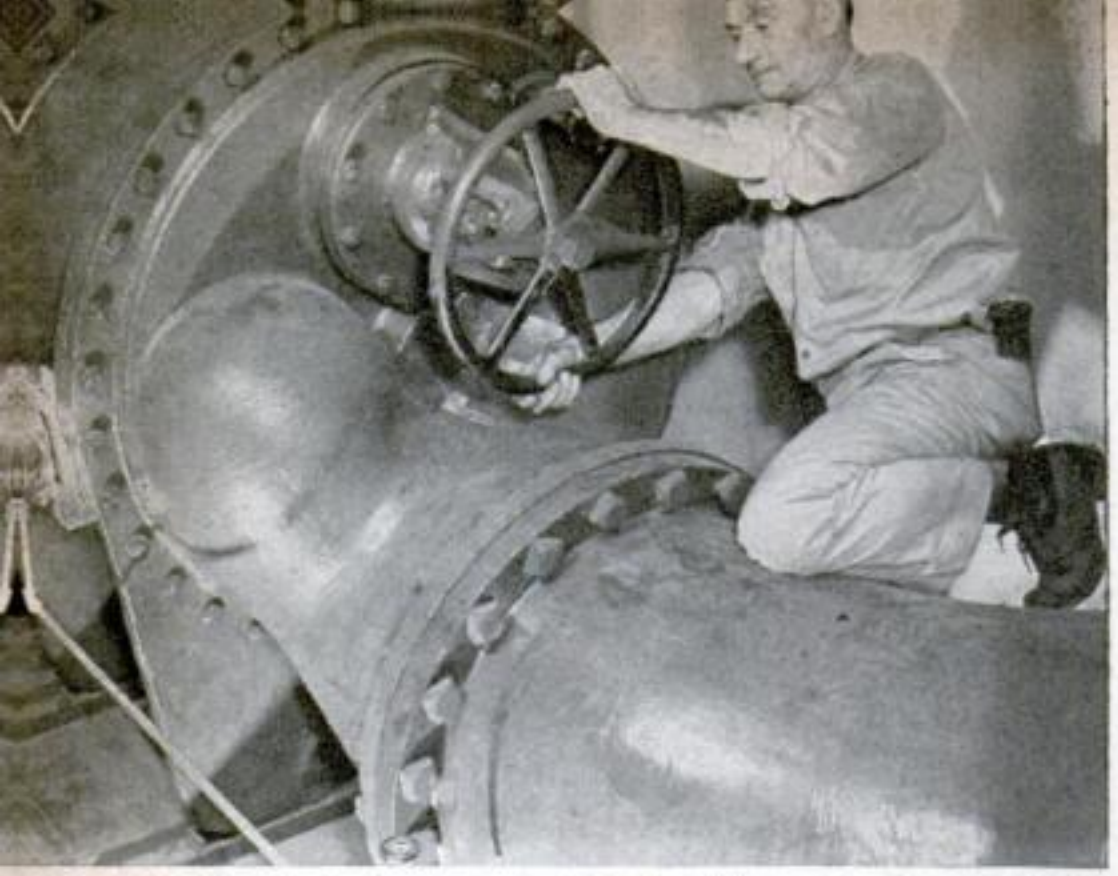
Another problem was reflections. Even unglazed paintings present annoying spots of glare when the angles of vision and of light are not properly related. The chief offenders are the tall canvases, where the line of vision turns strongly up. High ceilings, easily possible in this one-exhibition-

These floods light the museum only 15 percent of the time; the sun does 85 percent of the job

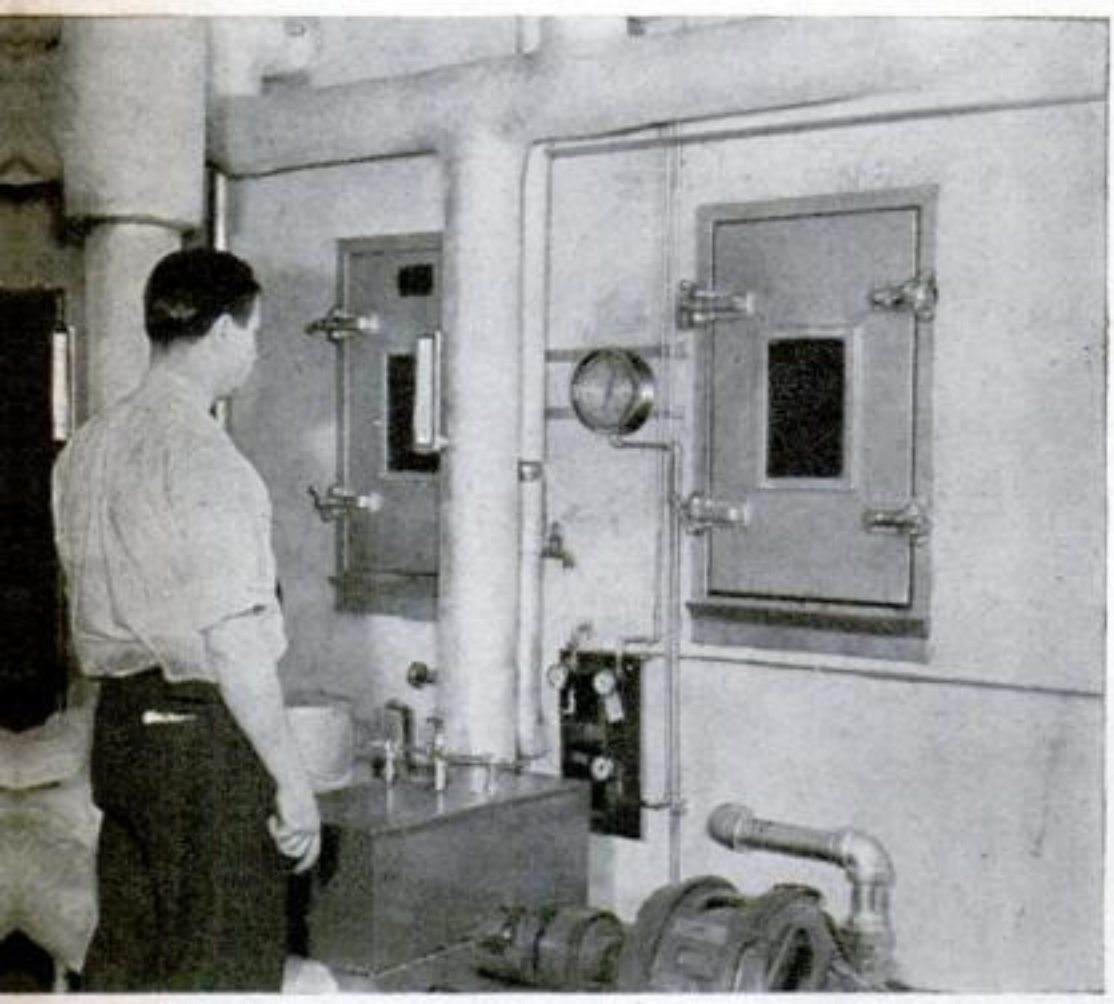
Sunlight is focused with these lenses on sculpture, which unlike paintings, needs highlighting

Roof and ceiling are both glass. Normal air is blown between them to push out some of the heat passing through. Instead of shattering if accidentally broken, special ceiling glass crumbles to harmless powder





A five-foot pipe carries 5,000 gallons of water a minute to the air-conditioning units and back to the ship canal



Washing the air and adding additional moisture, when it is required; humidity is kept constant at 50 percent

In this tank a finely atomized alkaline spray neutralizes the sulphur dioxide, an enemy of oil paintings present in all city air; at the right is one of the filters

floor scheme, are the best answer.

Washington's weather, sun, haze, fog, smoke, and a few other factors were measured in a twelve-month survey, and it was found that the top lighting plan would give the gallery sufficient light 85 percent of the time it would be open. For the remaining hours, there are the flood lamps on steel tracks above the lay lights. Their light may be varied at will in volume and corrected for color by individual filters.

The lay lights offered some minor problems. Breakage and falling glass had to be guarded against. Wire glass sufficed for the skylights above, but such reënforcement in the ceiling would have made a distracting silhouette. One of the newer discoveries in glass making was the answer. It is a glass a quarter of an inch thick, both faces of which are in tension. A blow sufficient to break it causes complete disintegration, so that the broken pane would sift down as a fine powder.

One staggering factor results from the top daylight system. The sun pours its heat through the skylights unchallenged. That hot air between skylights and lay lights has to be taken out in a hurry, before it can unload its heat into the galleries below. Twenty-eight blowers are the guardians, going into action as they are needed, and they can remove 700,000 cubic feet of air a minute.

And that brings us to the Gallery's air conditioning. Visitors must be comfortable and the paintings must

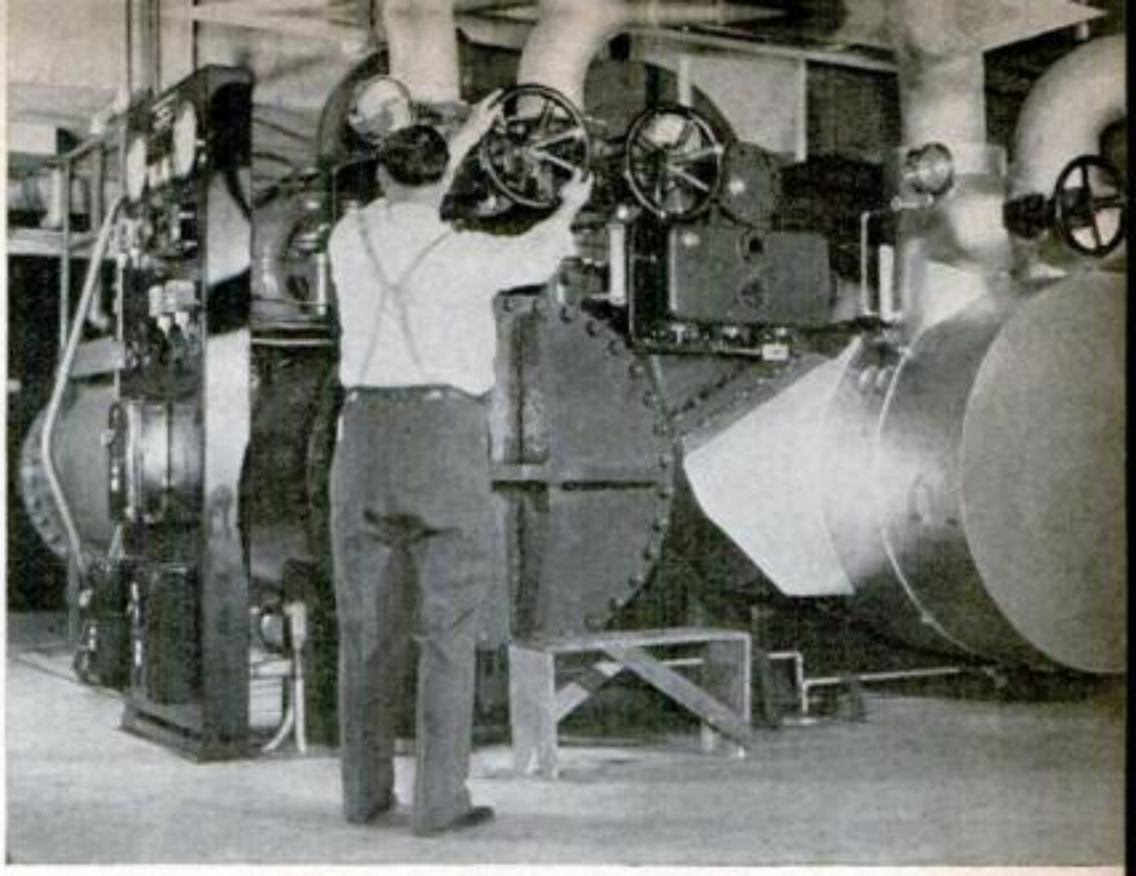
be protected against too much or too little moisture, too much or too little heat. Fortunately, the two aims do not conflict. To prevent deterioration of the canvases, a constant relative humidity of about 50 percent is best, and that suits all of us. The temperature will vary between 70° and 80°, going up and down with outdoor conditions.

Even with the blowers taking out that hot air under the skylights, the engineers estimate that, in the hottest weather, there must be removed from the gallery, each 24 hours, sufficient heat to melt 1,360 tons of ice. A five-foot conduit carries water from the Tidal Basin—5,000 gallons a minute—to the gallery and back again to the Ship Canal. In the basement a battery of compressors stands by to add refrigeration when it is needed.

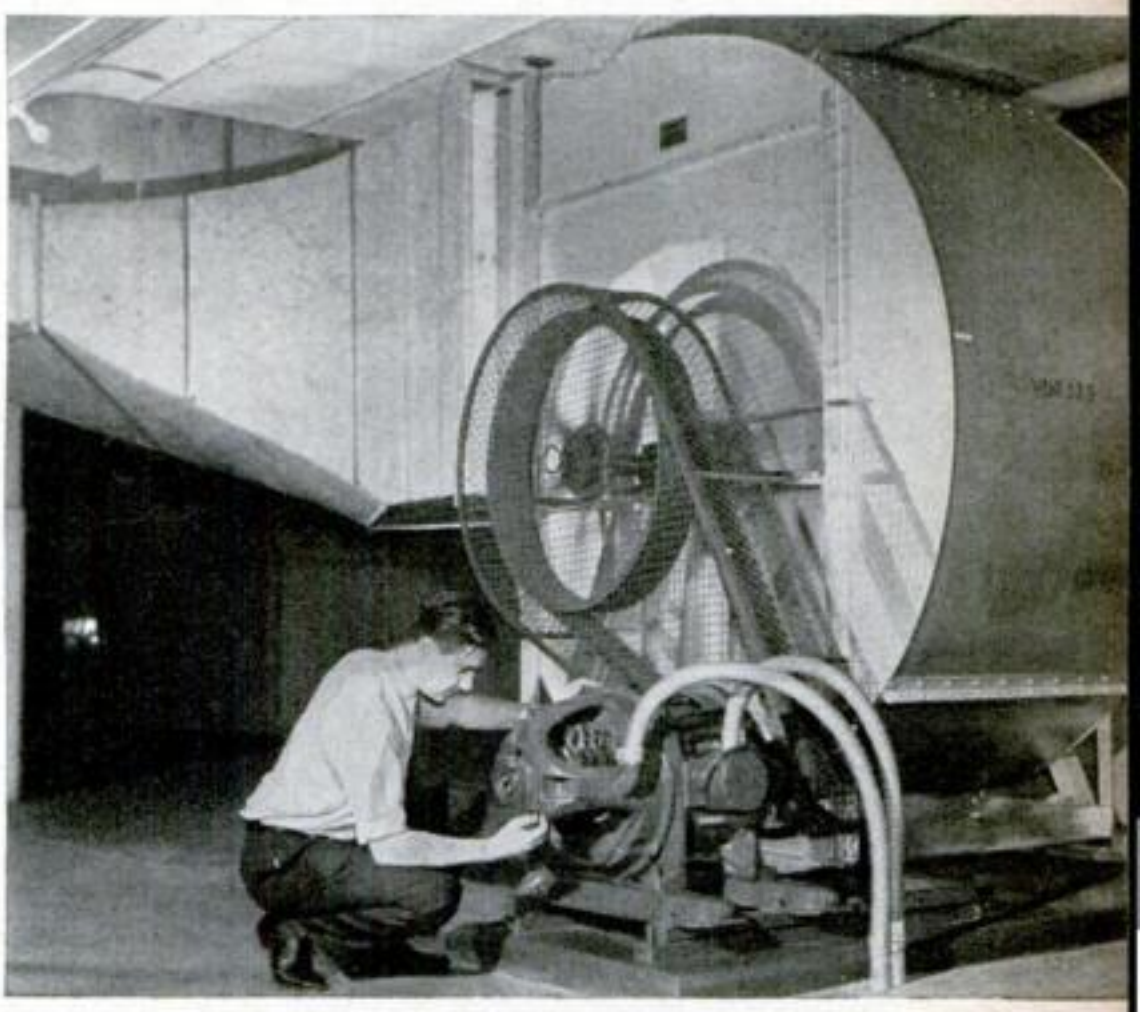
Seventeen air-conditioning plants serve their respective zones, and the ductwork for some of these, as seen in the basement, has all the complexity and grace of a cloverleaf highway crossing. Air in the gallery is changed six times an hour. On entering, the so-called "fresh air" (a poor thing compared to what finally goes into the galleries) is filtered through paper, pre-heated if cold, given moisture or robbed of it to achieve the proper degree of humidity, brought to the desired temperature, and delivered to the rooms. In addition practically all city air contains sulphur dioxide, an enemy of oil paintings. and this gas is neutralized by an alkaline spray, finely atomized, in each air-conditioning plant, and never reaches the rooms.

Down in the basement, a large Diesel engine stands idle. Beneath the water-tight basement floor the site is practically a series of sumps, open to surface water and to the nearby Potomac when it is on a rampage. Electrically driven pumps in a series take out of these sumps what water may collect, but in a flood or if the city's electric power were disabled, the Diesel automatically would go to work behind them.

On viewing the gallery from the street, with its three-blocks length, it is a shock to be told that the building is held up by friction. Three hundred carloads of Tennessee marble went into its exterior walls alone, aside from the brick, concrete, tile, and steel that form its floor slabs, wall backing, and internal structure. Sixty-eight

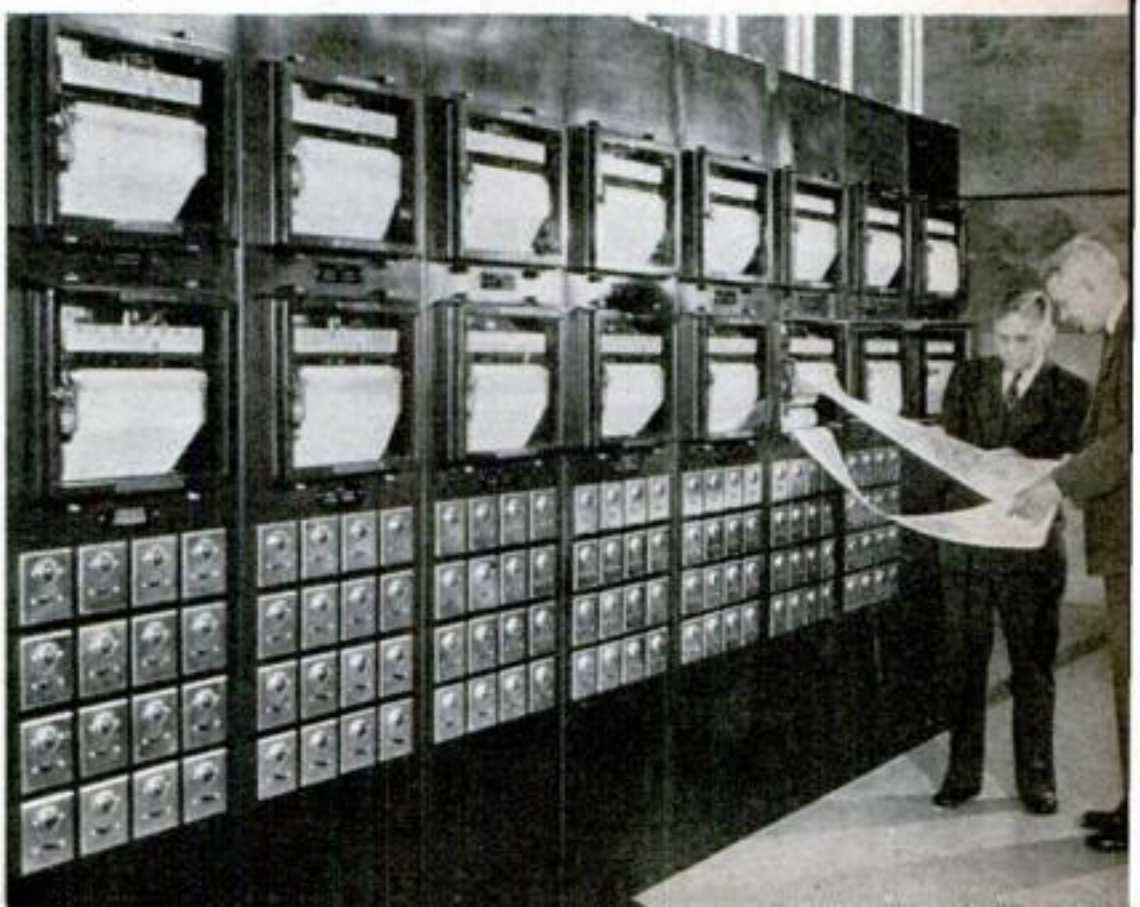


One of the gallery's air-refrigerating plants; 17 sets of ducts transport the purified air to the exhibition rooms



Blowers such as this change the atmosphere in the museum six times an hour, adding a third new air on each journey

The conditioning system's control board; it keeps records automatically of the temperatures throughout the gallery



For servicing the flood lamps, used when the sun fails, the workmen wear safety belts to avoid shattering the ceiling

hundred piles—pointed steel shells deeply driven and then filled with concrete—provide a frictional resistance with the soil that takes the place of foundation walls to bedrock.

If you were to ask a passer-by the color of the marble walls, the chances are that the answer would be "white." As a matter of fact it is a subtly graded range of light pinks, darkest at the base, blending to pale shell pink at the top. Rain brings out this color more noticeably. Here is the largest marble building in the world. There were grave doubts as to an adequate supply of one kind, and new quarries had to be opened up over a 35-mile deposit, yet the architects insisted that each stone, as quarried, be inspected for flaws in grain or uniformity, be wetted, then rated as belonging in one of the seven basic shades, with their 26 intermediate shades. Then it was cut, polished, marked for location, and shipped. Thirty-five hundred individual pieces went through this process—the work of 1,200 craftsmen for more than 20 months.

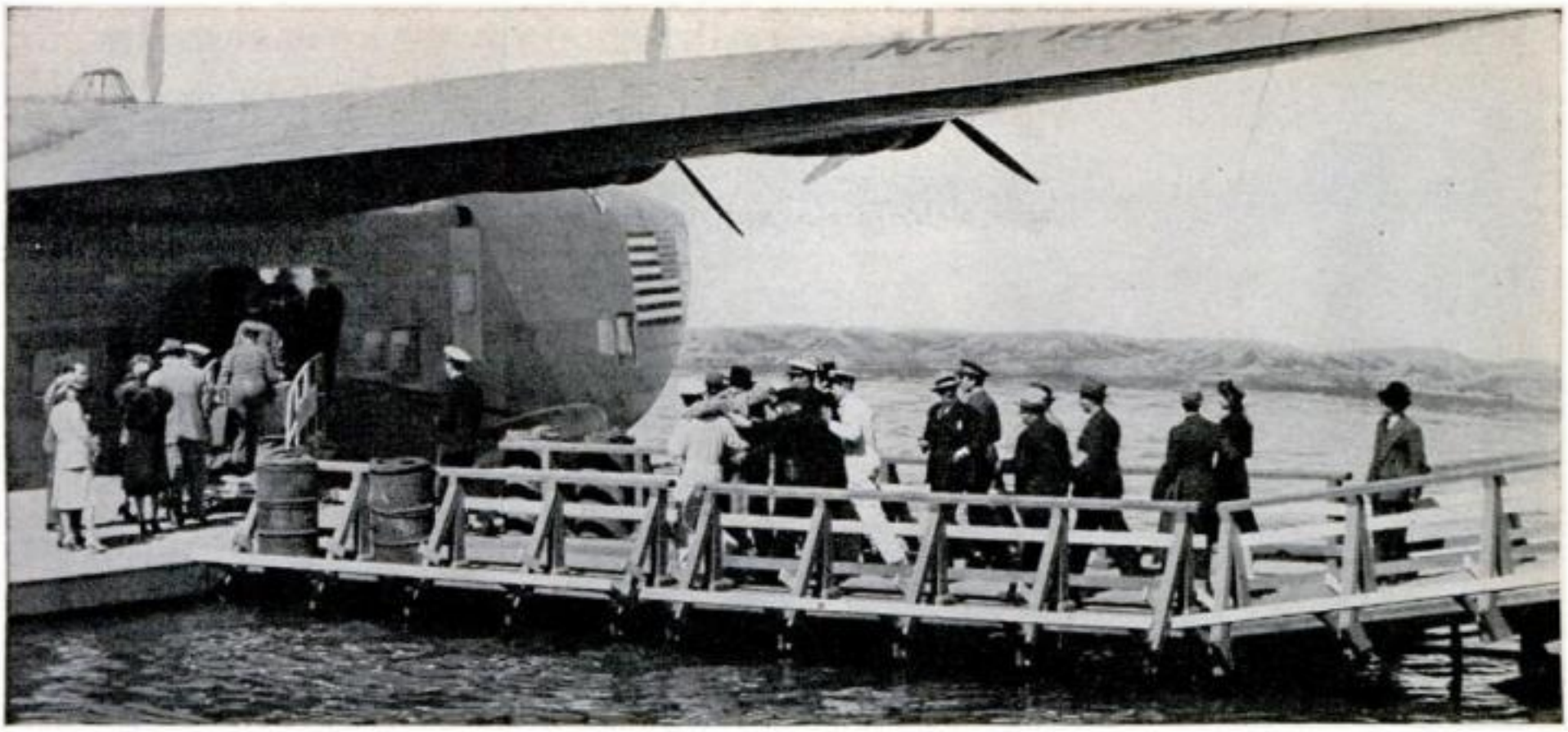
New methods of cutting stone were devised. In the two large garden courts, 32 columns of buff limestone support the glass superstructure. Each 24-foot shaft was cut from a single block weighing 40 tons, and turned to the precise taper desired, in a giant lathe. Sixty blocks were quarried and seasoned, to make sure of the 32 needed, and to one master mechanic was entrusted the lathe work.

Inside, the materials used cover a wide range. Quarries in Alabama, Vermont, Indiana, Tennessee, Missouri, contributed of their best; France was drawn upon; and from high up on Italy's west coast, 120 great ten-ton blocks of boldly figured dark green marble were put aboard ship just before war would have prevented. Oak, pine, mahogany, maple, teak, formed paneling and flooring; damask and other fabrics were specially woven to prevent sagging when stretched as wall backgrounds. Many of the individual galleries have unusually large wall areas of paneling; to avoid cracks, the wood is seven-ply veneer; to make possible the redivision of a wall, the background wood is one continuous sheet, and on this the stiles, rails and moldings may be rearranged at will.

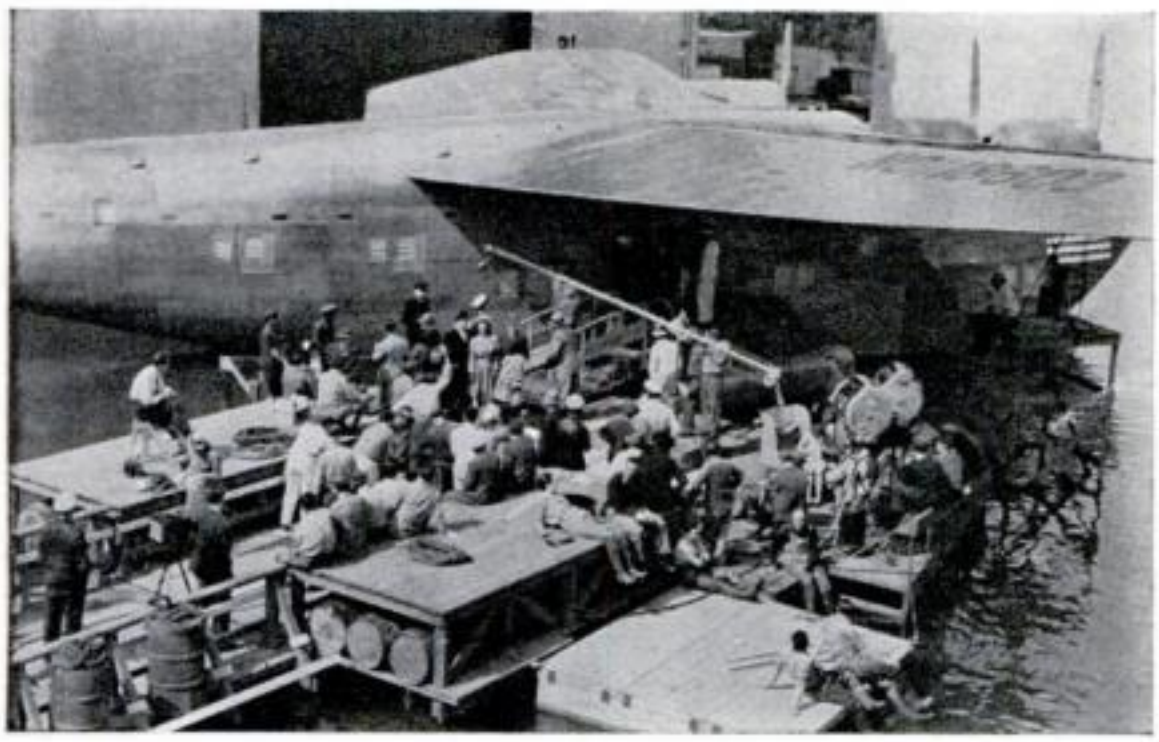
Protection is provided through an extensive organization of watchmen and guards, connected through a control desk with fire, police, telegraph, and District of Columbia administration offices. Great bronze doors guarding the portals, each leaf of a pair weighing six tons, can be closed instantly by electricity.

Noise is not a major problem in an art gallery. Visitors in the presence of the world's masterpieces do not shout. Even in certain of the more important rooms, where architectural fitness calls for walls and floors of reverberant masonry, voices are usually subdued. Nevertheless architects and engineers have not been relieved from acoustical treatment of the interior. The panel-like interior of the dome—"coffering" is the architectural term—breaks up sound waves by its intricacy of surface relief. This effect is aided by sound-absorbing elements that form the centers of all the coffers. All the machinery is insulated from the structure and base, with lead, cork, and rubber used as cushioning materials. In this way, no hint of the elaborate mechanical apparatus of the gallery is allowed to disturb the visitor and destroy the atmosphere that belongs to such a place.

Few of the thousands of daily visitors will see any of this mechanical ingenuity. That is as it should be, for all the ingenuity of the builders has been directed to creating a fitting background for great art, a background no more obtrusive than the clean air one breathes within these quiet rooms.



## Movie Clipper Taxis on Studio Pool, but Never Takes Off

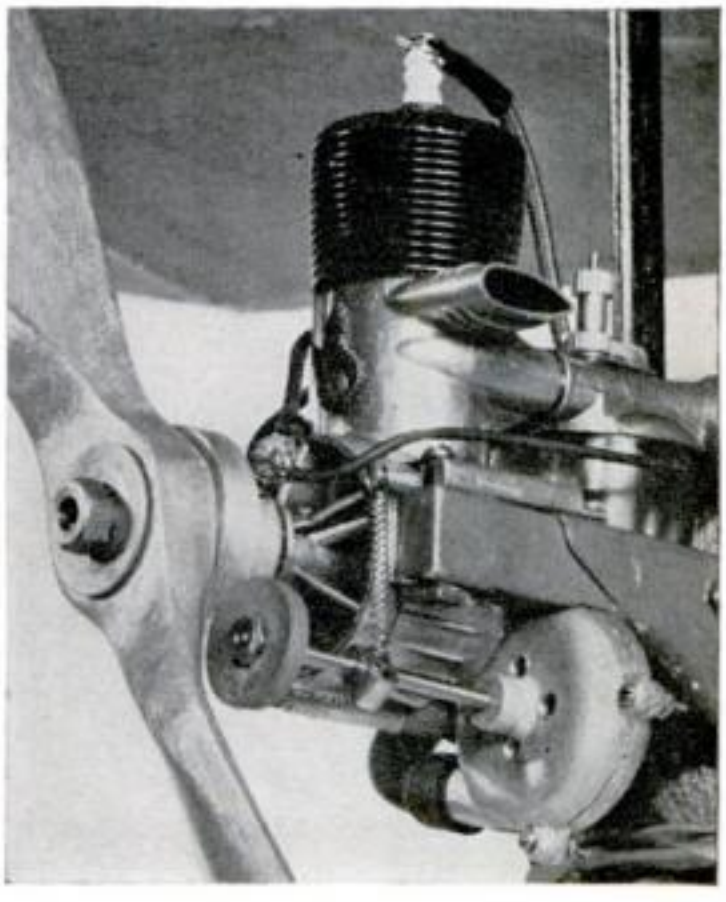


A painted backdrop whisks this studio Clipper to Lisbon

PROVING that things are not always what they seem, these photographs show a "prop" imitation of a Boeing Clipper plane which was manufactured by Warner Brothers technicians for use in making studio shots for the motion picture "Affectionately Yours." Resembling its prototype in all visible details, it can taxi under its own power but cannot fly. Shallow pontoons permit it to float in a 3½-foot-deep pool. The wings have a spread of 152 feet and fold back when the plane is being moved. For close-up shots the fuselage can be separated into sections.

## Supercharger Weighing 2¼ Ounces Peps Up Gasoline-Driven Models

TO HELP the model makers get the last ounces of power out of the miniature gasoline engines that drive their midget boats, planes, and cars, a supercharger has been developed that weighs only 2¼ ounces. It is claimed that the added power resulting from use of this unit more than offsets the extra weight. Driven by a wheel held against the engine flywheel, propeller hub, or driveshaft by a spring, the supercharger works on the same principle as those which give added power to full-size fighting planes and racing boats and cars. In addition to creating air pressure at the engine air intake to increase the oxygen supply, this unit gives the air rushing into the engine an added turbulence which materially aids combustion.



# Weed Boat Chops Up Water Hyacinths Choking Florida Canals

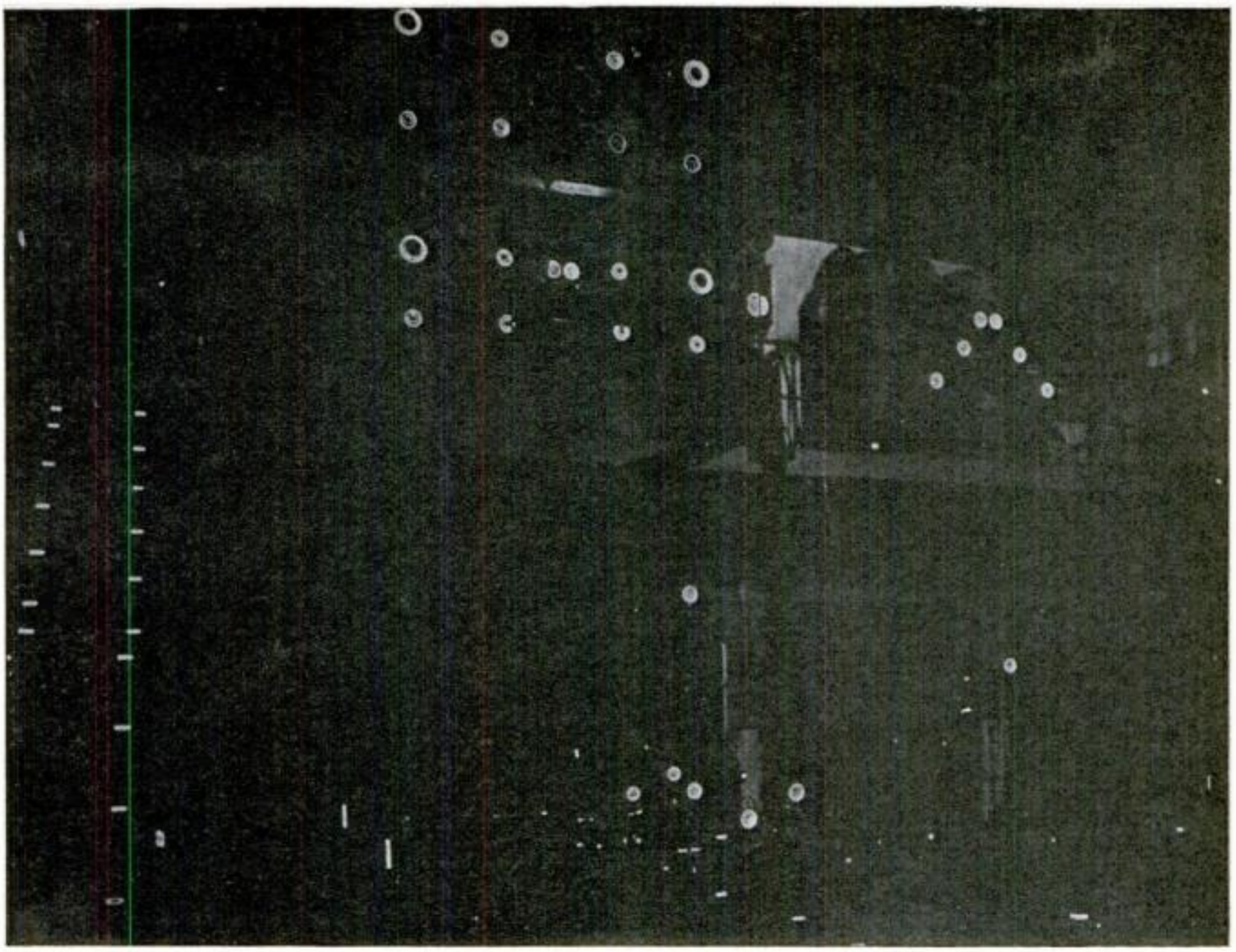
The hyacinths expand a thousandfold in six months, filling waterways so tightly they can support automobiles. A whirling knife under the apron of the weed boat cuts the plants to bits so they can be floated out when the locks are opened

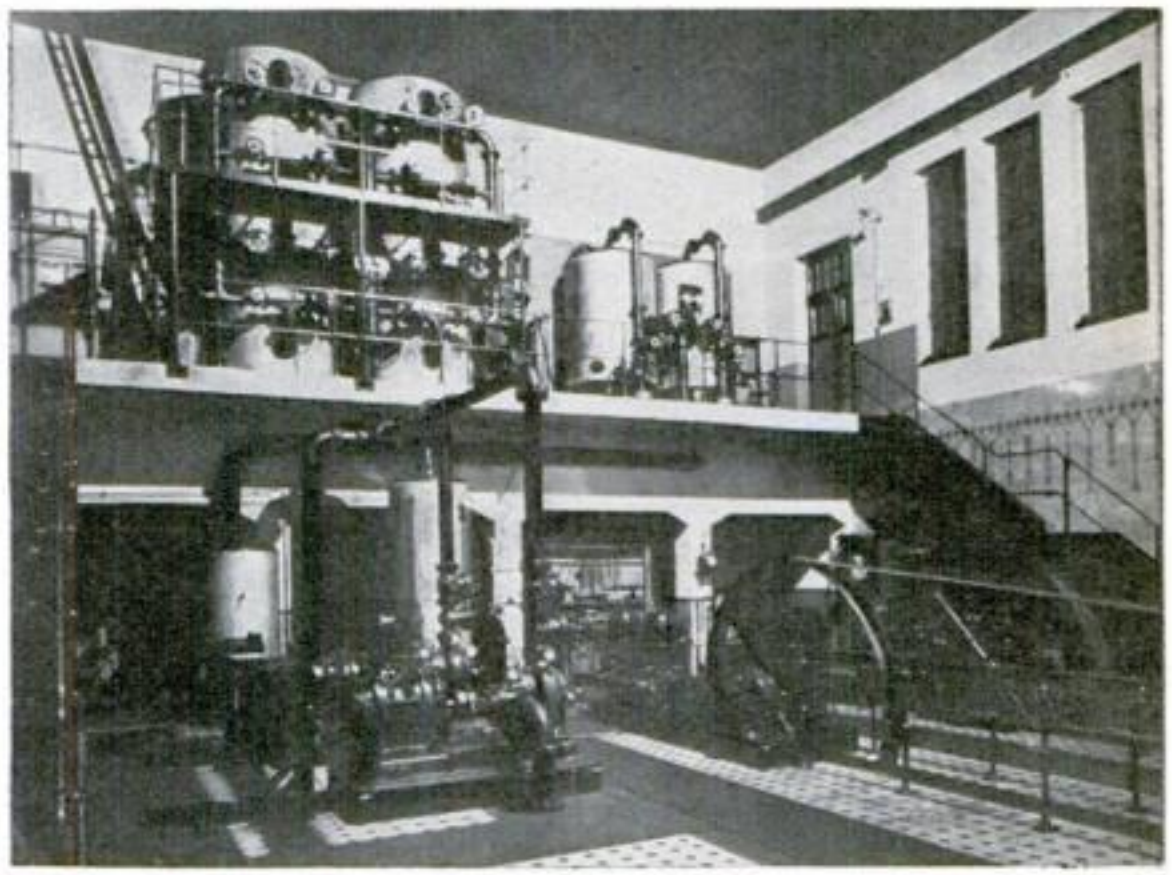
MILLIONS of flat, air-filled leaves of the water hyacinth, choking Florida canals with an almost solid mass of vegetation, are being removed with a shallow-draft "weed boat" invented by R. T. Lingle and C. W. Nipson, of the Lake Worth Drainage District, in Palm Beach County, Fla. As the 16-foot craft plows through infested canals, a 15-inch blade whirling beneath a wooden apron at its bow chops the plants into such small pieces that they can be floated out when control locks are opened. The hyacinths have been spreading since 1844 when they were introduced as a garden-pool plant. So rapidly do they multiply that one square foot of plants expands to 1,000 square feet in six months. Poison sprays, drag-lines with scoop buckets, and elevator barges with conveyor belts that tossed the plants out on the banks, have been tried in past efforts to conquer the botanical pest.

## A Filling Station on Wheels

A MIDGET service truck, placed on the market by a Springfield, Ohio, manufacturer, saves steps for mechanics at used-car lots. The truck can be pushed, on its two rubber-tired wheels, into position beside any car which needs servicing. If the tires of the parked auto are soft, air from a compressed-air tank on the truck will inflate them. If the fuel tank is dry, a two-gallon can of gasoline, mounted beside the air tank, will provide enough fuel to drive the car to the pump. And if the engine proves balky, there is a booster battery mounted opposite the gasoline can. Thus, the rolling service station can put any car on the lot in shape for a demonstration, or at least get it moving.

# Invisible Rays in Blackout Plant Make Dials Glow





Both these pictures show the same scene in a power house. In the top picture, instruments and walkways alone show up, their special paint glowing under invisible light. Below, under normal lighting

GHOST LIGHTS shine in German power plants during air raids, but there is no stray gleam from the plant windows. To accomplish this, vital gauges, levers, switches, control wheels, stairs, ladders, and walkways within the plants are painted with chemicals which glow only when illuminated with the invisible rays from special lamps. Thus, during a complete blackout, workmen can tend the machinery and instruments and production can continue without interruption. The slight visible glow coming from the painted surfaces is ample for vision against the black background, but too weak to be visible even a short distance from the plants should doors or windows be opened. The system is one answer to the problem of maintaining wartime production during blackouts, particularly in connection with emergency maintenance of factory power plants and public-utility control stations. In the accompanying pictures, a station is shown with normal and "ghost" lighting.

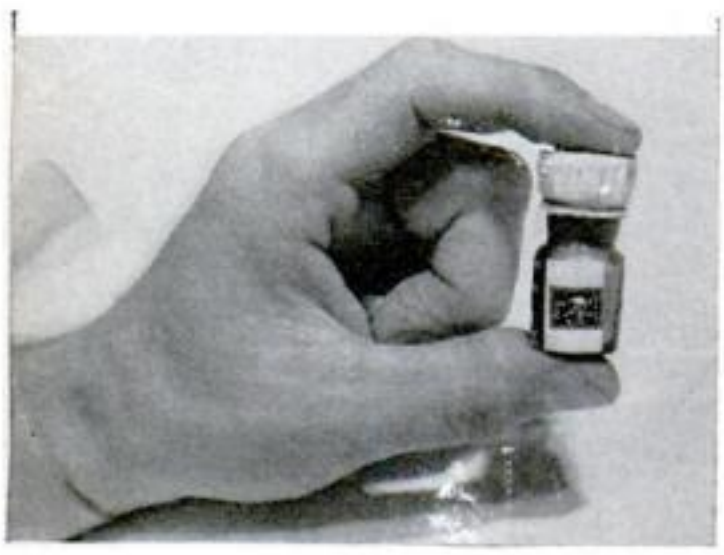
# HE GROWS A POISON GARDEN

MAKING POISON plants more poisonous is the hobby of Dr. William J. Bonisteel, professor of botany and pharmacognosy (the science of basic medical materials) at Fordham University. At his farm at Pine Plains, N. Y., in the garden of his Scarsdale home, and in a greenhouse at Fordham, he spends every moment available hybridizing and chemically treating an array of plants that would arouse the envy of a Borgia. A tiny bottle of poison from his deadliest is enough to kill 750 men! Yet, in minute doses that same alkaloid allays pain and may even save life. That is the reason for Dr. Bonisteel's research.

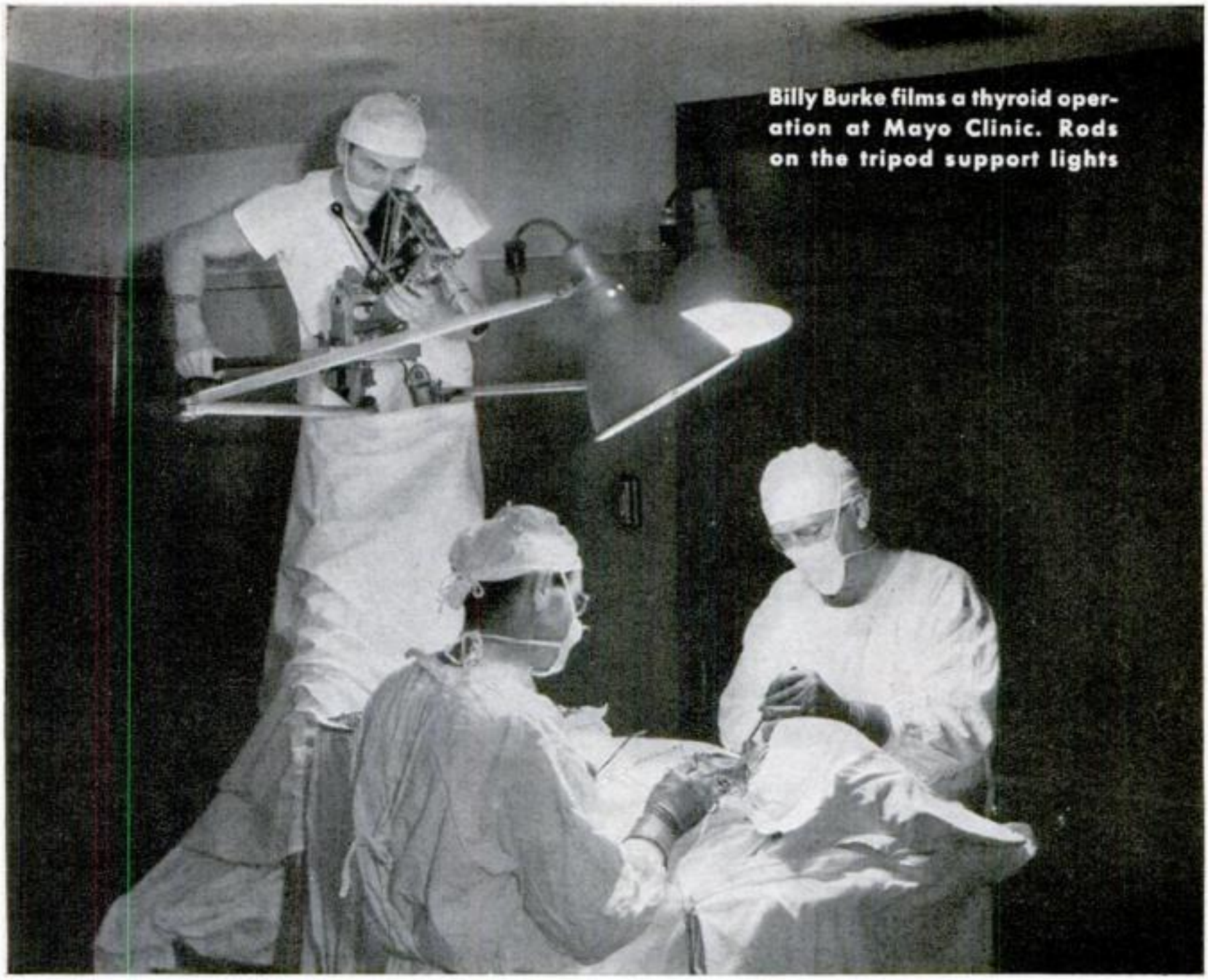
He is experimenting with 98 kinds of plants, trying to produce new varieties by grafting and by treating the seeds or roots with colchicine, an alkaloid poison extracted from the seed of the meadow saffron. The chemical increases the number of chromosomes, the microscopic bodies which transmit inherited characteristics. Treating wolfsbane, or monkshood, with colchicine is particularly promising. Dr. Bonisteel has discovered that a hybrid of Cinchona tree yields almost twice as much quinine as its parents. The East Indies now produce 95 per cent of the world's supply of this drug, and if war should cut off our supply, this knowledge might become extremely valuable to Americans.

Professor Bonisteel is experimenting with these two kinds of digitalis to see which can be made to yield more poison

The low aconitum's roots were treated with colchicine to increase the number of its chromosomes in an effort to make it deadlier while the tall one developed naturally



This vial contains enough poison, derived from a plant Dr. Bonisteel grows, to kill 750 men, but minute doses allay pain and may save lives



Billy Burke films a thyroid operation at Mayo Clinic. Rods on the tripod support lights

# Cameraman in White

BY ANDREW R. BOONE

BILLY BURKE, a Texas cowboy turned photographer, has filmed more surgical operations than most persons outside the medical profession will ever see. During the last ten years he has made 500 full-color motion pictures of operations ranging from delicate brain surgery to work on muscles and tendons.

Much of this work has been done in the operating rooms of southern California hospitals, though some has been recorded in his own Hollywood studio. And because his background of prize fighting and cow-punching failed to provide the necessary technical knowledge, he has had to study hundreds of volumes on medical subjects so he could make an accurate record of the work of the surgeons.

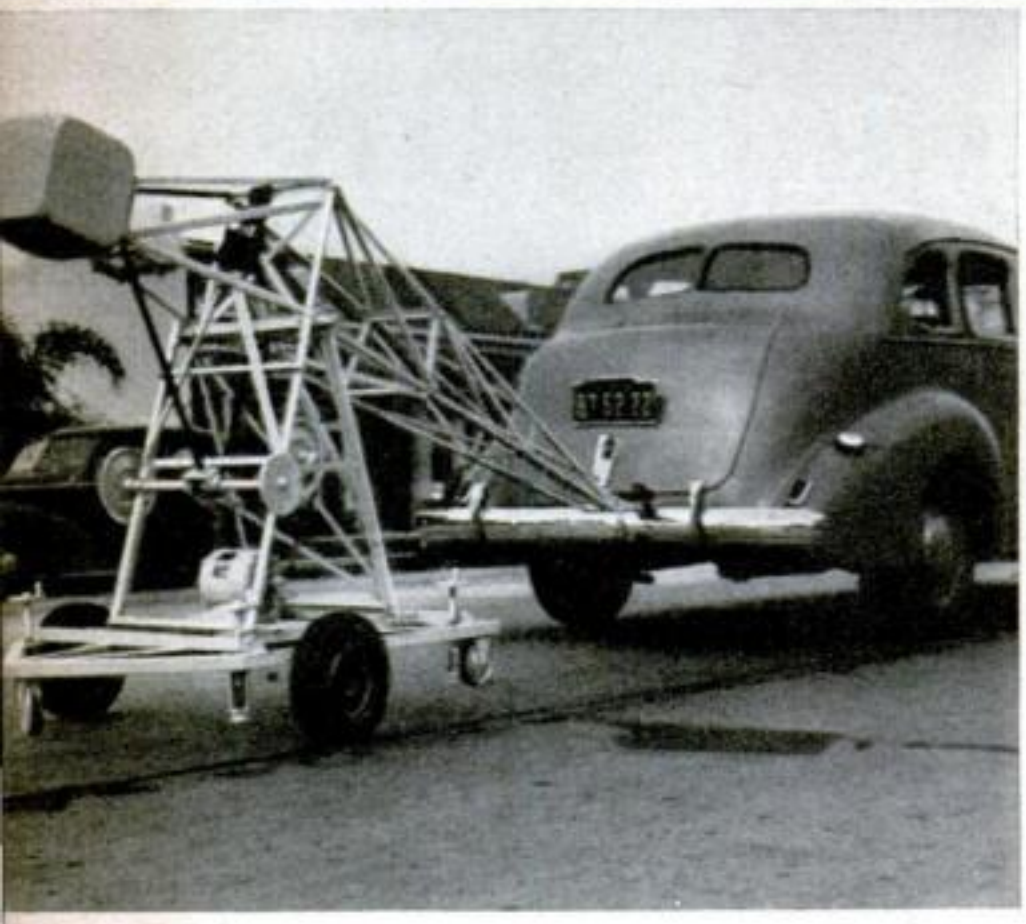
Burke's plans for his future didn't include photography when he left his father's ranch near Moro, Texas, for a year in the Texas Cavalry, and later, a hitch in the Navy. While boxing aboard ship, he decided he was the man to beat Jack Dempsey, but gave up that field of endeavor when he came out of a ring with a broken jaw.

A few months later he was riding for a Tom Mix picture near Victorville, Calif., when the cameraman on the job, Don Short, suggested that Burke might make a good cameraman. The cowboy liked the idea, and was soon working as a newsreel cameraman in Hollywood.

His introduction to medical photography came when Dr. Roland Frost walked into the office of George Richards, where Burke was working, and said he wanted some one to make a picture showing abdominal surgery. None of the available photographers wanted the job so they drew straws, and Burke, the loser, got the assignment.

That first medical job was a failure from

Two floodlights and two spots provide shadowless illumination for a demonstration of the technique of local anesthesia. Below, the crane rides on a special trailer equipped with airplane wheels



beginning to end. Burke started his work in the operating room by dropping his camera into a sterile tray. Then one of his lights exploded, showering the patient with bits of glass. Finally when the 1,150 feet of film he had exposed was developed, it was, from one end to the other, a blackout!

The experience aroused his interest, however, and Burke went to work in earnest. Now he has developed his own technique and equipment, and turns out pictures so good that several of them were shown at the recent meetings of the American Medical Association in Cleveland and aroused great interest.

To hold his camera in position, Burke made a 350-pound crane, modeled after the bigger ones used in the motion-picture studios. By mounting it on two small airplane wheels, he can tow it behind his car to whatever hospital he wishes. His camera is a 16-mm. Eastman Cine-Kodak Special. To avoid the possibility of sparks igniting the ether fumes in the operating room and causing an explosion, the electric cable connections to the photoflood lamps he uses are carefully taped, and the camera is operated by a spring motor instead of an electric one.

Even after ten years, Burke still finds new problems. Recently Dr. Clifford B.

Burke prepares to photograph guinea pigs fed on Vitamin C. This picture was taken in his studio, where he shoots many scientific investigations, though he films operations mostly at hospitals

Walker, a specialist in eye surgery, walked into the studio with a glass eye from which dangled a number of colored threads.

"Can you photograph the entire action of the eye muscles?" he asked.

"We can try," was all Burke promised.

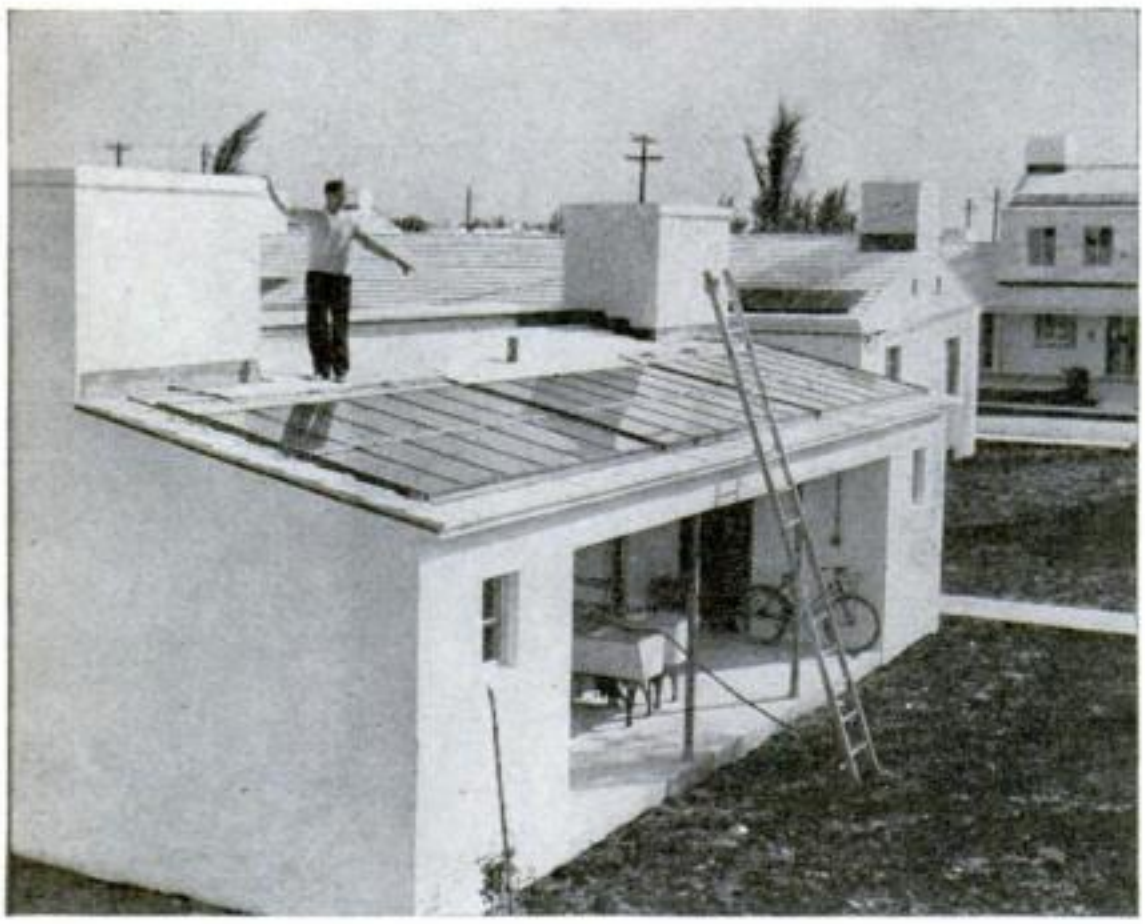
A few months later he was able to show to a group of southern California doctors their first colored motion pictures of the human eye and the muscles which control it.

No effort is made to record sound during the filming of the pictures, but later Burke meets with the surgeons in a laboratory where they record a sound track explaining the operation involved.

Burke disclaims any special ability and says that his success was achieved "by trial and error." But special ability or not, he is an acknowledged expert in a field far removed from bronco-busting and cow-punching. And in the Hollywood bank vaults where his films are stored lie valuable records of the workings of the human anatomy. They are valuable alike to doctors studying new methods of saving lives and curing illnesses, and to students seeking to learn the intricacies of the human system.

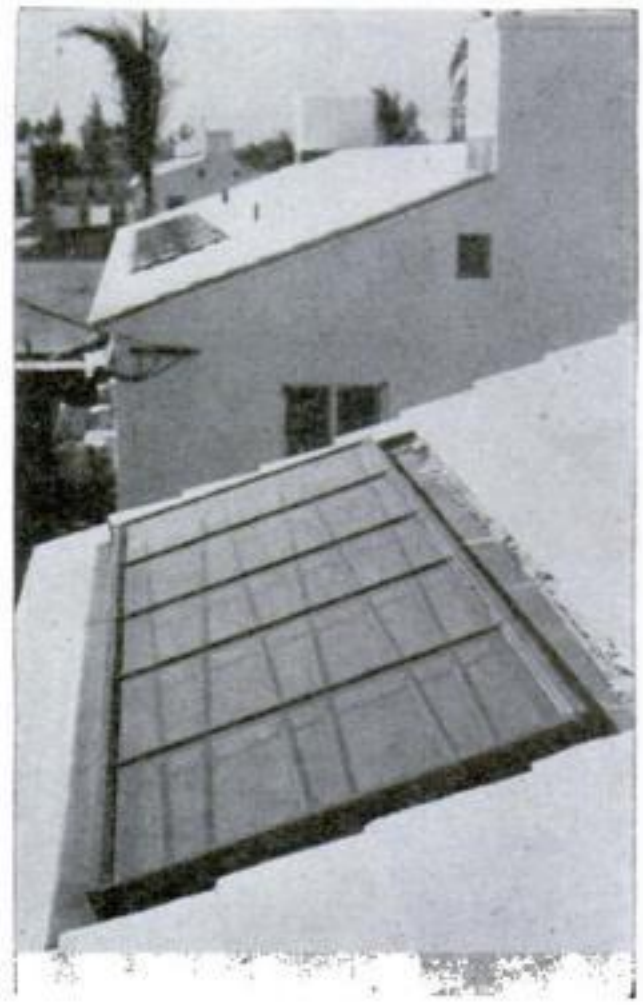
A prism of his own design lets the cameraman work directly above the eye. His lights are placed so that shadows do not get in the way, no matter where the surgeon places his hands

# The Sun Is Used to Provide Hot Water in Florida and Hawaii



Installing a sun heater in Florida. The shallow, glass-covered boxes supply hot water without fuel cost

The water is warmed to 180 degrees in a few hours as it runs through copper pipes underneath the glass

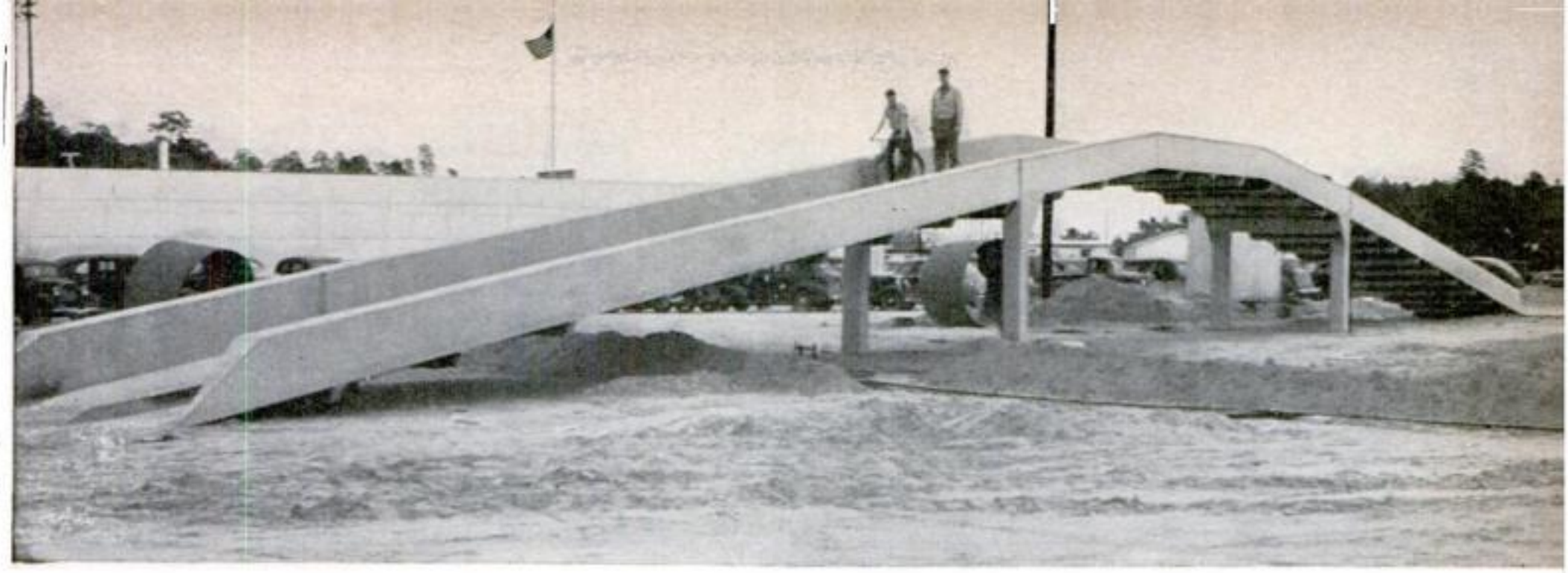


SOLAR HEATERS are being installed in Government housing projects in Florida and Hawaii to provide hot water. The sun heats the water to 180 degrees in a few hours as it runs through a series of copper pipes built into shallow, glass-covered boxes on the roof. A well-insulated tank holds the heat loss to less than seven degrees in 24 hours. The first cost is slightly higher than for conventional heating systems, but there is no fuel bill.

## Mimeo Drawing Board Is Instantly Adjustable

AN ILLUMINATED drawing board for mimeograph work has been developed capable of instant adjustment to any angle required for easy and quick stencil illustration. The glass top is set in a single piece of molded plastic, which permits easy and precise control of the T square when it is used either vertically or horizontally. Line stops are supplied for ruled form work. A handy switch turns on evenly distributed illumination. At the bottom of the board is a receptacle to hold the mimeograph styluses and other drawing instruments. The whole stands firmly on a three-point base.

A single piece of molded plastic holds the glass top, permitting precise and easy use of the T square on all sides. At the bottom is a holder for styluses



This metal bridge, built to speed up traffic, can be moved if the flow shifts later. Linton Hopkins Jr., the inventor, shows how it works with a dummy

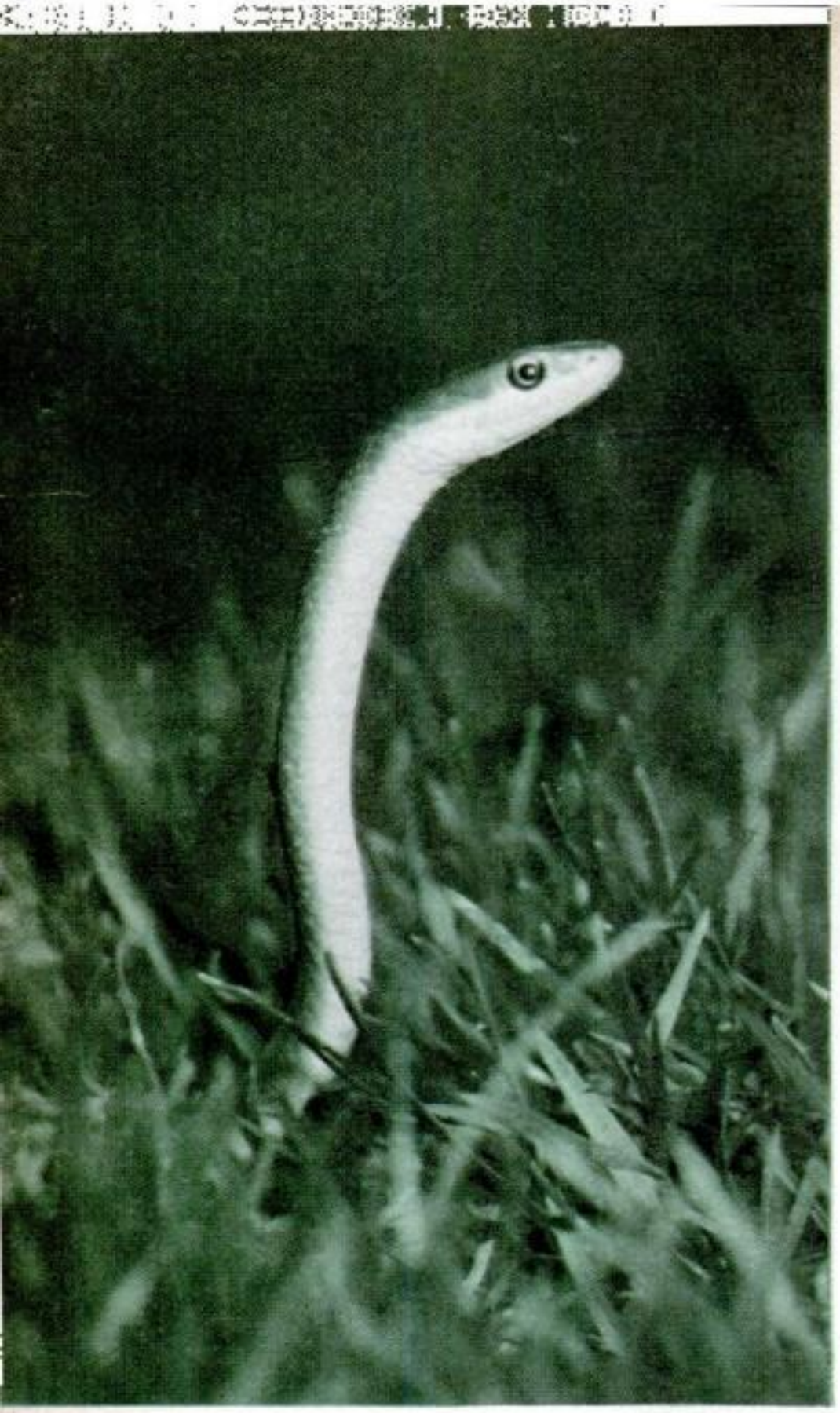
## Portable Traffic Overpasses Can Be Set Up Where Needed

LINTON HOPKINS, JR., state news editor of "The Atlanta Journal," has designed a portable metal bridge to speed up traffic at busy street intersections. The bridge eliminates the need for red lights, and permits an uninterrupted stream of vehicles in every direction, thus emptying congested areas in much shorter time than is the rule now. Hopkins feels that the portable feature makes it practicable to install the bridges where it would be too expensive to build regular overpasses, such as in mushrooming defense areas, since if traffic centers shift, his bridge can be taken apart and moved to where it is most needed. The R. G. LeTourneau Company is building the bridges, at Toccoa, Ga.

## Dictaphones Save Time of Stock Checkers Taking Inventory



BY ASSIGNING five men equipped with dictaphones to the job of inventorying its 350-odd grocery stores regularly, the Safeway Stores on the West Coast has given its store personnel 12 extra nights off a year. A checker from the central office covers two stores a night, speaking into a microphone hung around his neck, as he moves along between the rows of goods, calling out the location of each shelf and the quantity, container size and price of each item. Usually eight cylinders are enough for each store, and after the record has been transcribed, the disks can be lathed down and used over again.



Recent experiments show that the snake's tongue is part of an extraordinary nose, and is used in locating food

SCIENCE SOLVES ANOTHER RIDDLE:

# Why a Snake Flicks Its Tongue

*Photos by the American Museum of Natural History*

**By BARRETT McGURN**

THE SNAKE'S flickering tongue, recent experiments have proved, is part of a super nose, very useful in finding food, in courtship, and even, in the case of the female, in caring for its eggs. Every schoolboy knows that despite its wicked look the tongue is not the snake's fangs, that instead the poisonous varieties inject their venom from hollow teeth, similar to a doctor's hypodermic needle. But until lately not even the wisest biologists knew the function of the constantly darting fork. Some experiments in Germany and a great many more in this country, chiefly in the laboratories of the American Museum of Natural History in New York City, spelled out its meaning.

The sense of smell, like the sense of taste, is chemical. That is, when you smell something it means that some very tiny floating particles have gotten into your nose and united chemically with a part of you. The snake has a nose, and smells the same way, but in addition, in common with most land animals having a backbone, it also has a curious device in the roof of its mouth called, after a Danish physician of a century ago, its Jacobson's organ. This is an auxiliary nose, and what the snake's tongue does is go out and get those tiny floating particles and bring them in to it.

The experiments showed that the snake depends far more on its tongue and Jacobson's organ than it does on its regular nose to find its prey. The biologists sealed up the nostrils of one set of snakes and removed the Jacobson's organs from another set. Those with sealed-up noses weren't even handicapped, but those deprived of their Jacobson's organs were out of luck.

Many varieties of lizards have tongues and Jacobson's organs just like those of snakes, and since lizards are more primitive than snakes, Dr. G. K. Noble, E. R. Mason, and Katherine F. Kumpf, of the Museum, used lizards for a number of their experiments, on the theory that the lizards would be less complicated. For their use, more than 100 race runners or whiptail lizards *(Ameiva exsul)* were rounded up in the vicinity of Bayamon, Puerto Rico.

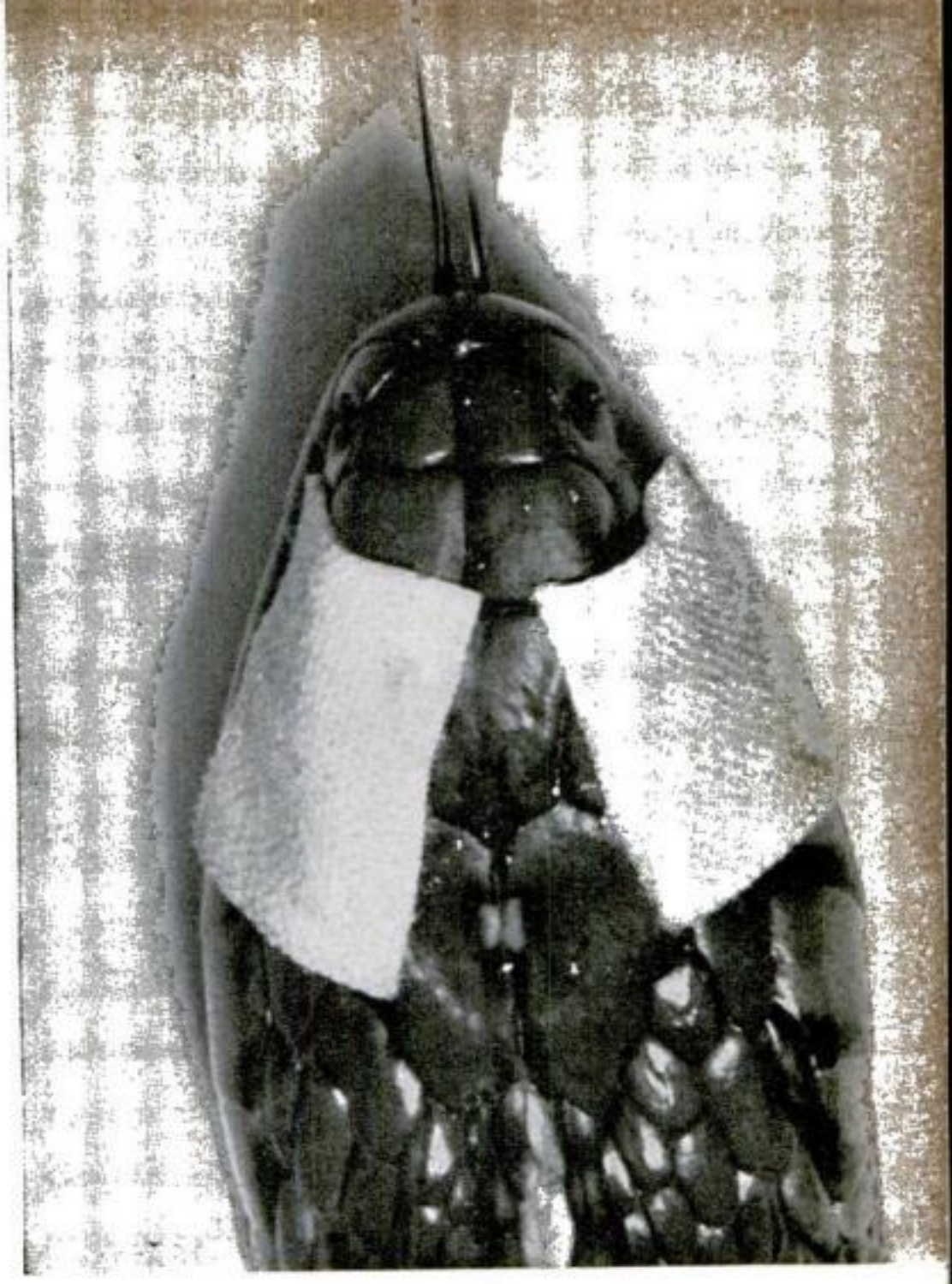
To discover whether or not its tongue is of any use to the lizard in finding buried food, the biologists blindfolded a set of lizards, plugged the nostrils of another, removed the tongues of a third, and destroyed the Jacobson's organs of a fourth. They

made various combinations of these operations on still others, and left some free of all handicaps. In a thoroughgoing scientific way, they made doubly and trebly sure they were blotting out each sense. To make sure the blindfolded ones could not peek, they not only covered the lizards' eyes with adhesive tape, but also painted that with a reddish-brown ink that retouchers use in shutting out the light of a photographic negative, then covered it with a thin coat of collodion.

Yet the blindfolded lizards actually managed to find buried food quicker than those able to use all their senses. In 720 tests, hunting with unplugged noses, tongues, and Jacobson's organs, they located and rooted up food in an average of 24.4 minutes. Those able to see took five minutes more. The biologists figured this was because they took time out to watch people moving around in the laboratory and other distractions.

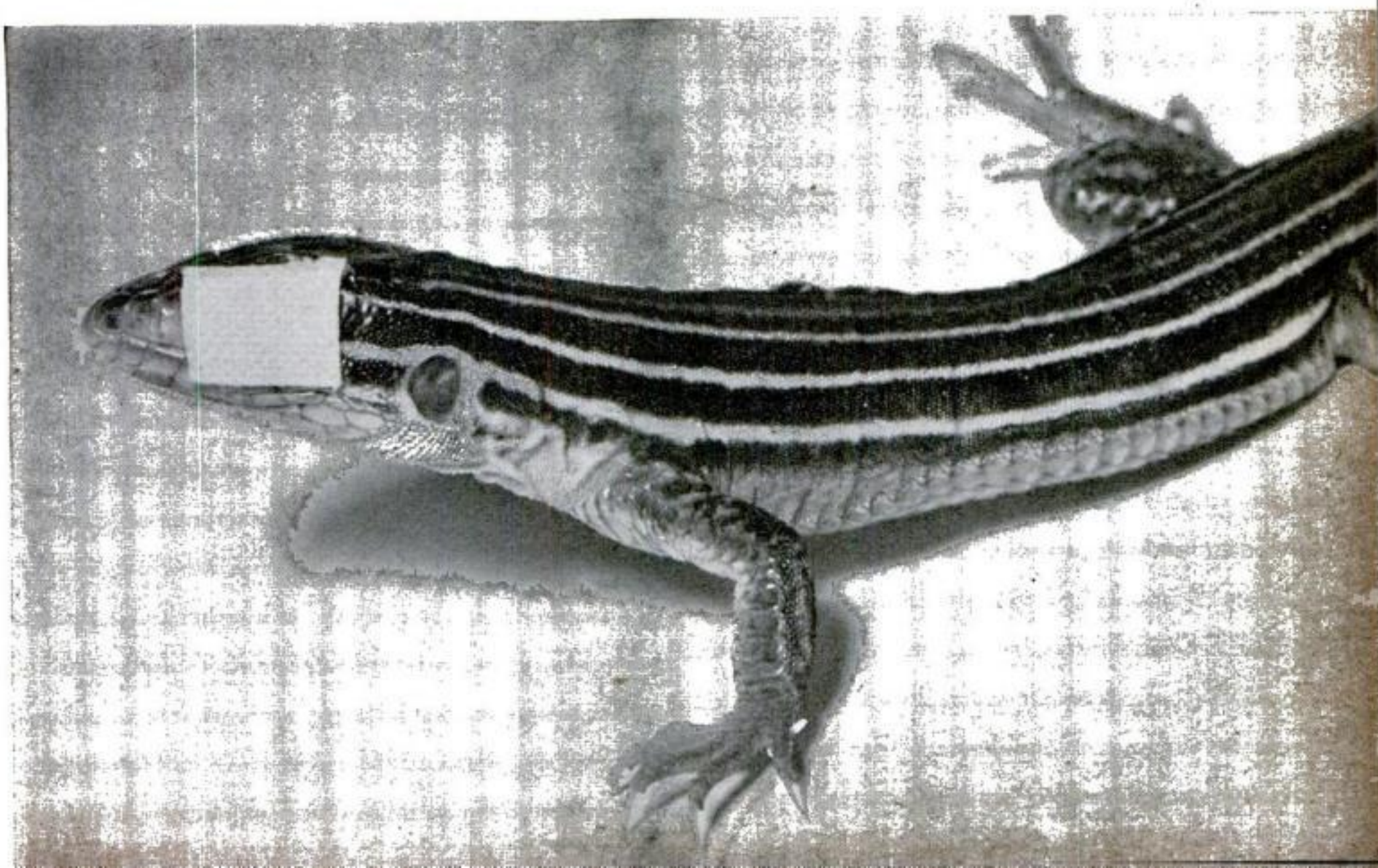
On the other hand, the lizards which had been deprived of their Jacobson's organs made a poor showing. With their darting tongues no longer any help to them, they searched with eyes and nose and finally found food in an average of 33 minutes a try.

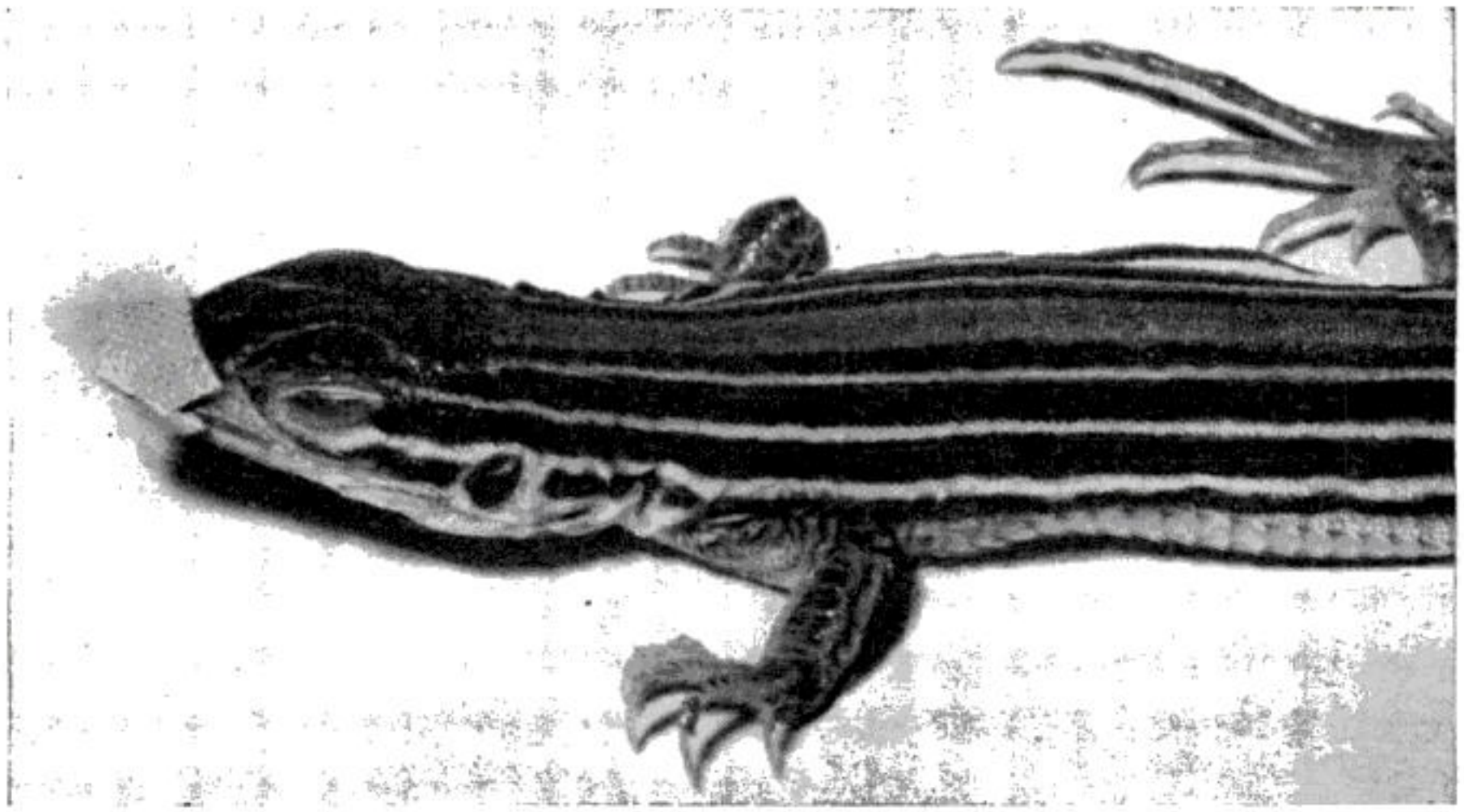
Experiments on southern skinks, a variety of lizards known scientifically as *Eumeces laticeps,* showed the value of the tongue to brooding females. One of the skinks which had just laid her eggs was blindfolded, and her nostrils were sealed. Then she was set



Biologists blindfolded a garter snake and observed it not only made love without the slightest handicap, but even rid itself in two minutes of a rival able to see

When blindfolded the whiptail lizard found and dug up buried food five minutes quicker, on the average, than when it had eyes open to all the passing distractions





The lizard was licked when deprived of both nose and tongue, but plugged nostrils alone didn't matter

free. The experiment was tried repeatedly, and each time the eggs were moved, but the skink never failed to find her unhatched offspring and to resume brooding them. In one try she found them in the record time of ten minutes.

Apparently the female skink—and the snake—uses her tongue not only to find her eggs, if they are moved, but to identify them. With a flick, she can tell whether or not someone has put the eggs of some other species, or rocks resembling eggs, into her nest in her absence. To determine whether the tongue is indispensable, the experimenters removed the skink's blindfold, unplugged her nose, then took out her tongue. Although she could see, and could smell with her regular nose, she did not return to the eggs this time.

Snakes themselves were studied in large numbers to discover the uses to which the extraordinary tongue is put in reptilian courtship. The biologists focused their attention on 50 of the common eastern variety called Dekay's snake *(Storeria dekayi)*. It was observed that the males always flicked their tongues very rapidly when they went courting. There is little difference in color between male and female snakes, yet the males never wasted any attention on other males. Gliding up to another snake, a male would flick its tongue over the other's back, much as one dog sniffs at another. The observers could not tell which was male and which female, except for their action, but subsequent examination by the biologists always proved that the male had correctly identified the other as a female.

Further studies indicated that the male did it by picking up, with his tongue, a distinctive odor of the female skin. Several common garter snakes *(Thamnophis sirtalis)* were blindfolded, as thoroughly as the lizards had been, then turned loose. As soon as they got used to the tape, they resumed their courtship of females in the cage.

Curiously, the blindfolded males seemed to be at no disadvantage, even when unencumbered males started courting the same female. One blindfolded garter snake courted a female of his species for nine minutes, lost her for 30 seconds, then found her again in the company of another male garter snake who was able to use all his senses. The blindfolded snake managed to polish off his rival in another two minutes and went back to his courting.

A further series of tests made on groups of common garter snakes and Butler's garter snakes *(Thamnophis butleri)* proved that it is possible for a snake to court when deprived of either its regular nose or the tongue-and-Jacobson's-organ combination, so long as it still has the other, but that actually they generally lose interest when either is removed. A few of the common garter snakes courted with one or the other smelling apparatus missing, but none of the Butler's garter snakes would have anything to do with sex under those circumstances. The fact that they could see made no difference.

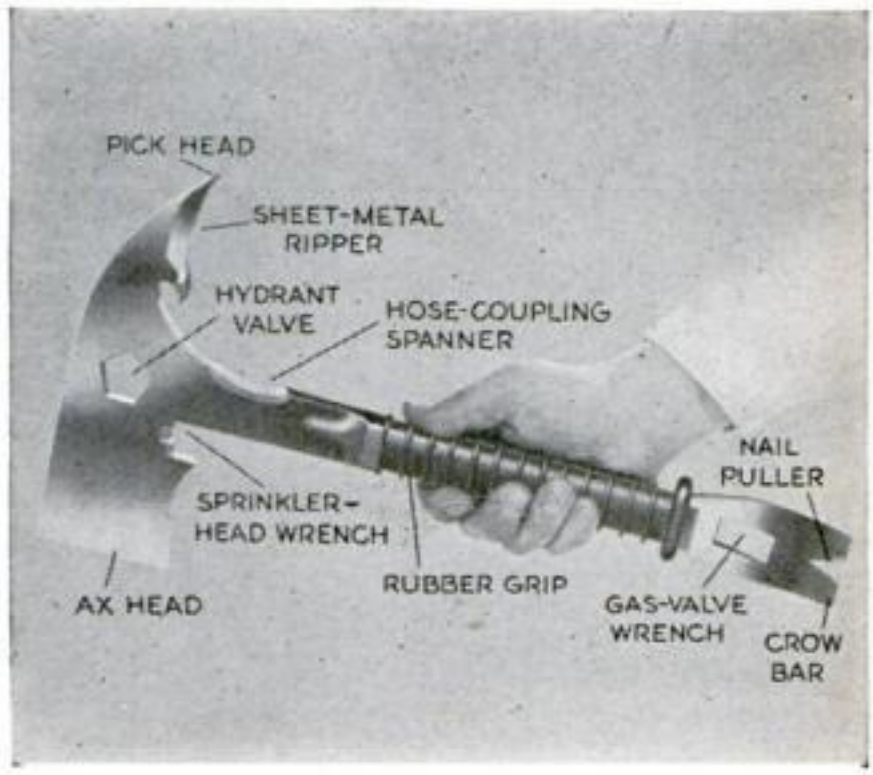
The studies still are going on, for the biologists feel that they have not yet learned all there is to know about the remarkable uses to which reptiles put their so often misunderstood tongues.

# New Tools

**LIGHT ON A REEL.** Attached with brackets to a wall or ceiling, a combination lamp and cord reel supply light just where it is wanted. As much cord as desired may be drawn out, and the lamp hooked to a convenient support. Unhook the lamp, and a gentle tug starts the reel winding in the cord, as shown in the illustration at right. If the reel is mounted on a garage ceiling above the engine of a car, the lamp will prove useful for making motor adjustments and repairs.

**THREE-FACED OILSTONE.** Both honing and finishing operations may be performed, and a wide variety of tools sharpened, upon an oilstone of new design for home-workshop enthusiasts. Three grades of abrasive, varying from coarse to fine, are provided in handy form to be used successively, by arranging the surfaces in triangular form. Simply turning the assembly exposes the desired face. The illustrations show the three-way stone and the bench mount in which it securely rests.

**SHOCKPROOF EMERGENCY TOOL.** More than 100 uses are claimed for a new combination tool, designed especially for firemen and police. Since its rubber grip offers protection from up to 12,000 volts of electricity, electric wires and cables may be chopped away without danger of shock. The alloy-steel blade makes short work of wood and sheet steel. In addition, the tool may be used as a chisel, pry bar, spanner, nail puller, and a wrench for hydrant, sprinkler, and gas connections. Possible users besides those mentioned include light and power plants, water works, hospitals, and airports.



# *Steel-Rubber-Oil—*

with these, industry is creating powerful war vehicles to give speed and terrific fire power to our new defense forces

The 28-ton, M-3 medium tank moves a 75-mm. cannon, a 37-mm. antitank gun, and four .30 caliber machine guns at 30 miles an hour

# Battle of the Billions

## American Industry Mobilizes Machines, Materials, and Men for a Job as Big as Digging 40 Panama Canals in One Year

By RAY MILLHOLLAND

IT LOOKS like some outsider is continually forgetting that we Americans are a nation born with the smell of machine oil in our hair and that if we are crowded too hard we are liable to stop making electric refrigerators and pretty automobiles and devote all our attention to turning out the darnedest flock of airplanes, tanks, and battleships the world has ever seen. The first time this happened to us there wasn't even a rusty musket apiece to go round, and foxy old Uncle Ben Franklin solemnly proposed—and the other party believed him!—that if we were to put up any fight at all we would have to equip at least one regiment of the Continental Army with bows and arrows.

We were in the subcellar of unpreparedness if there ever was such a place, for there wasn't a single power-driven lathe on the whole North American continent. Just the same, from the backwoods forges of the Green Mountains and from the Lancaster County hills of Pennsylvania there came an ever-increasing supply of long-barreled rifles so deadly that no person with a grain of horse sense dreamed of wearing a red jacket within 300 paces of the muzzle of one of those nasty things.

Now once more a bad-acting outsider has forgotten that on no less than five important occasions in our history we have changed practically overnight from a nation of easygoing Yankee tinkers to a tough army of grim-faced sweating gunsmiths. Our present national defense program, in addition to providing us with a two-ocean navy and the largest and most powerful mechanized army necessary to meet any conceivable emergency, also proposes to supply the tools of defense to any good-neighbor country threatened by ruthless invaders.

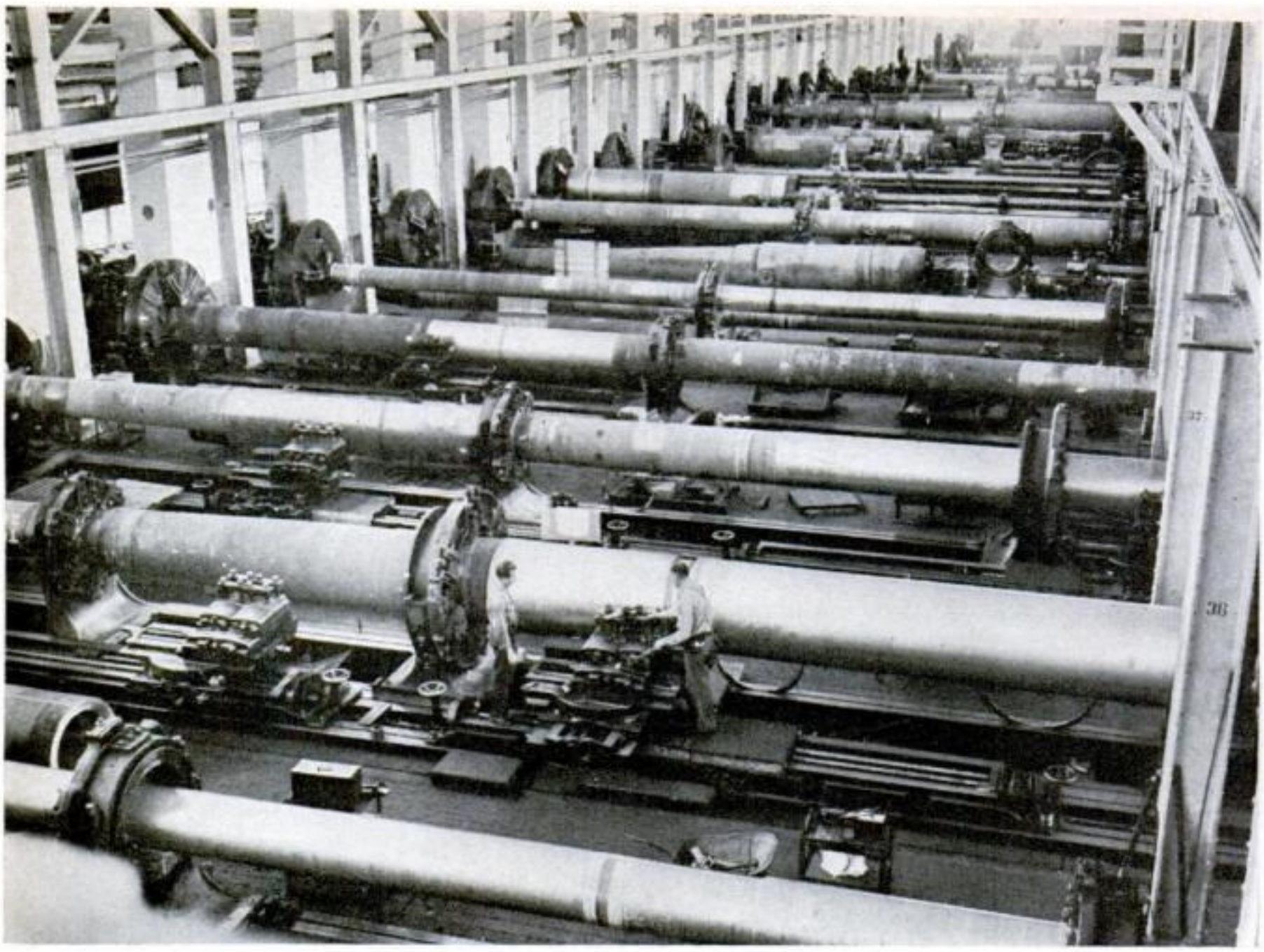
It is futile to attempt to appraise this Gargantuan defense program in terms of the billions piled on billions it is going to cost, for the keenest human intellect can not comprehend the magnitude of even one billion dollars. However we are warned by William L. Batt, Deputy Director, Division of Production, Office of Production Management, that Germany is now spending the equivalent of 20 billion American dollars per year on her war program and that we must be prepared to exceed that. Or, by way of comparison, the Panama Canal, which required ten years to build at a cost of approximately a half billion dollars, has long been considered one of the great man-made wonders of the world; but our present national defense program calls for the equivalent of the effort necessary to construct not one but 40 Panama Canals, not in ten years but in *one* year!

How desperately unprepared was the United States for assuming this rôle as the arsenal for all good-neighbor nations is revealed by the fact that less than two years ago almost 70 percent of our metal-working machinery—on which this vast quantity of arms must be manufactured—was more than ten years old. Much of this over-age machinery has depreciated until it is now of little use to the national defense program.

As every machinist knows, you cannot work to tolerances of a fraction of a thousandth of an inch on a worn-out lathe. To build a ponderous 28-ton tank, which has the outward appearance of having been hammered out by an angry blacksmith, actually requires hundreds of machine operations where errors of just one thousandth of an inch cannot be permitted. To complicate the problem further, the manufacture of machine guns, torpedoes, bomb sights, and airplane engines involves many machine operations where an excess error of one tenth of a thousandth turns an expensive part into worthless junk.

All of which means that vital elements of the national defense program can be produced only on new machine tools specially manufactured to super-accurate dimensions themselves. This has created a frantic demand for what can be called the master machines of national defense, and our only source of supply is the American machine-tool industry which just missed mass bankruptcy by the skin of its teeth in struggling through ten years of depression.

The last good year for the machine-tool industry had been 1929, when it did less than 200 million dollars worth of business. Orders slumped to less than 30 millions in



Lathes for making big guns take as much as a year to build. The crescent-shaped objects, under the gun tube where the two men are working, are micrometers for accurately gauging the diameter

Gargantuan metal turning; a bar of 18-percent tungsten high-speed steel clamped in the tool slide of a giant lathe puts the final touches on a big naval gun. Most of our tungsten for use in high-speed steel now comes from China

1933, and at fire-sale prices at that. Just a year ago the United States Government began to realize the gravity of its unarmed position in a world seething with wars of invasion. Official attention then was directed upon the machine-tool industry. Which is to say that overnight every maker of lathes, drill presses, precision grinding machines, gear cutters, milling machines—all metal-working machines needed for the production of defense articles — was asked to stoke up that idle boiler in his power plant and start building machine tools on a day-and-night working schedule.

For the year 1940 the machine-tool industry boosted production from that all-time low of less than 30 millions to 400 millions, or an increase of 1,300 per cent! But this was barely enough to equip a few pilot lines for the production of defense materials in limited quantities. The industry was called upon to double production again

and is well along to fulfilling its promise to supply 750 million dollars worth of desperately needed master machines for 1941.

William S. Knudsen, co-director with Sidney Hillman, of the Office of Production Management, in a recent address warned the nation that the production of national defense materials cannot be achieved on any easygoing "business as usual" basis. Big Bill, who when he talks about mass production never talks foolishness, listed the following huge production schedule as only part of the main program:

50,000 airplanes (Plus an additional 500 heavy bombers per month ordered recently by the President.)
130,000 aviation engines
17,000 heavy cannon
25,000 light cannon
13,000 trench mortars
33,000,000 artillery shells
300,000 machine guns
400,000 Garand semiautomatic rifles
1,300,000 Springfield rifles, with bayonets
113,000 motor trucks
25,000 trailers
106,000 field telephones
144,000 miles of telephone wire
Plus—a two-ocean Navy, and 200 additional cargo ships!

Big Bill warns that this is a full-time job for every skilled worker, for our best management brains employing our finest materials and requiring the erection of hundreds of additional factories. This job, he says, will require 28 billion man-hours of skilled labor during the next 28 months. "Every machine shop and every foundry in the United States which can make even a piece of something must be enlisted for the duration." He might well have added, yes, and every basement hobby-shop enthusiast will be called upon to turn out small defense parts after his regular work is done.

Many are the emergency methods being employed to provide an ample supply of skilled labor where it will be most needed. The U. S. Employment Service is calling for all workers outside the national defense program who have unused skill to register immediately at their local state free employment offices. This appeal was made especially to older men who had left their trades and who had become discouraged by traveling hit-or-miss about the country looking for work. Register at your local state employment agency if you are a skilled mechanic, is the advice right now. Then sit tight and a defense job will hunt you up.

Public schools throughout the country are installing secondhand machine tools of the type most nearly like those used in local defense plants, so that unskilled workers can receive basic training and semiskilled workers can be graded up in skill. Y. M. C. A. night classes have been organized for the same purpose and many private trade schools are doing effective worker training. The National Youth Administration and W. P. A. are also conducting worker training courses.

One of the interesting sidelights of the defense program is the manner in which newspaper editors have taken the reports of raw-material prices and supply off the inside back page and are now displaying them as page-one news. The "Big Six" of the raw materials these days are Rubber—Aluminum — Copper — Petroleum — Steel—Coal. These make the headlines because of the vast quantities of each consumed daily by the defense program. Steel, with its components coke, limestone, and iron ore, forms the backbone of the defense program, naturally. The job of moving iron ore from the upper Great Lakes ports is one of the really tremendous transportation problems of the world. More cargo tonnage passes through the Sault Sainte Marie locks in the nine months of the Great Lakes navigation season than is handled in 12 months by the Panama and Suez canals combined.

Recently aluminum has made headlines on page one of our newspapers. The domestic demand for aluminum in a brisk business year used to run about 300 million pounds. The demands for airplane con-


## Our Cover

*FOR this month's cover, Harold W. Kulick snapped two of Uncle Sam's sky troopers, a lieutenant and a sergeant of the 501st Parachute Battalion stationed at Fort Benning, Ga. They are wearing their outfit's combat uniform, cut like a ski suit and made of foliage-green silk with a slick finish to prevent snagging in the shrouds. The plane is a Douglas DC-3, a common transport type with the addition of a cargo door. Twelve parachute troopers can bail out of it in seven seconds.*

struction have increased consumption to 700 million pounds for this year, while the estimated requirements for 1942, when mass production of planes is expected to really get going, may run as high as a billion pounds. It is only natural then that aluminum was the next item after machine tools placed on the priorities list by the O.P.M.

Copper, like aluminum, is needed in vast quantities for defense. It is used in the manufacture of electrical goods—wire, motors, power-plant generators—and soon will be in heavy demand as the base metal for brass cartridge cases. Domestic supplies of copper ore and smelting capacity are sufficient for almost any possible need.

Petroleum is worrying the Axis partners far more than it need worry us with our almost unlimited supply, which is to be available not only for ourselves but for all other nations eligible under the Lease-Lend Act. Germany and Italy are being forced to carry on the aggressor's burden of the war with only five percent of the petroleum products, both synthetic and natural, which the United States is now producing.

The Axis partners are especially short of 100-octane gasoline, of which we have an abundance and with still more refining capacity being built. This 100-octane gasoline means that a supercharged airplane engine designed for use with it will deliver 20 percent more horsepower than another engine using 90-octane gasoline. It so happens that 90-octane gasoline is the best Germany so far has been able to produce, and then in such limited quantities that only careful rationing, to the utter exclusion of nonmilitary consumption, keeps her war machine from stalling.

Dr. Robert E. Wilson, petroleum expert of O.P.M., recently made this report to a congressional committee: "The gasoline consumption of Germany during the few weeks of fighting in the low countries and France exceeded the entire consumption during the entire first World War." Yes, our petroleum and 100-octane gasoline production is critical—for Germany.

Other raw materials are being carefully husbanded by the materials division of O.P.M. We use annually more than 500,000 tons of chromium ore in the manufacture of stainless steel, high-speed steel, and special steel for ball bearings and nonshrinking die steels. A large part of this tonnage of chromium ore is used without metallurgical refining in the production of firebrick for steel-melting furnaces.

Making a 37-mm. cannon. Raw materials are nickel steel, rubber, copper, zinc, tin, chromium, manganese, molybdenum, asbestos, vanadium, and silicon

. . . and the result is poison to dive bombers and light tanks. The 42,000 cannon to be built in the next 27 months will need more than 33,000,000 shells

At the present time most of our chromite ore is imported from Africa and the Philippine Islands, over trade routes that may be interrupted at any moment. But a year's reserve of high-grade ore, over and above current arrivals from abroad, gives us sufficient leeway to develop American low-grade chrome-ore deposits and expand our existing ore-treating plants.

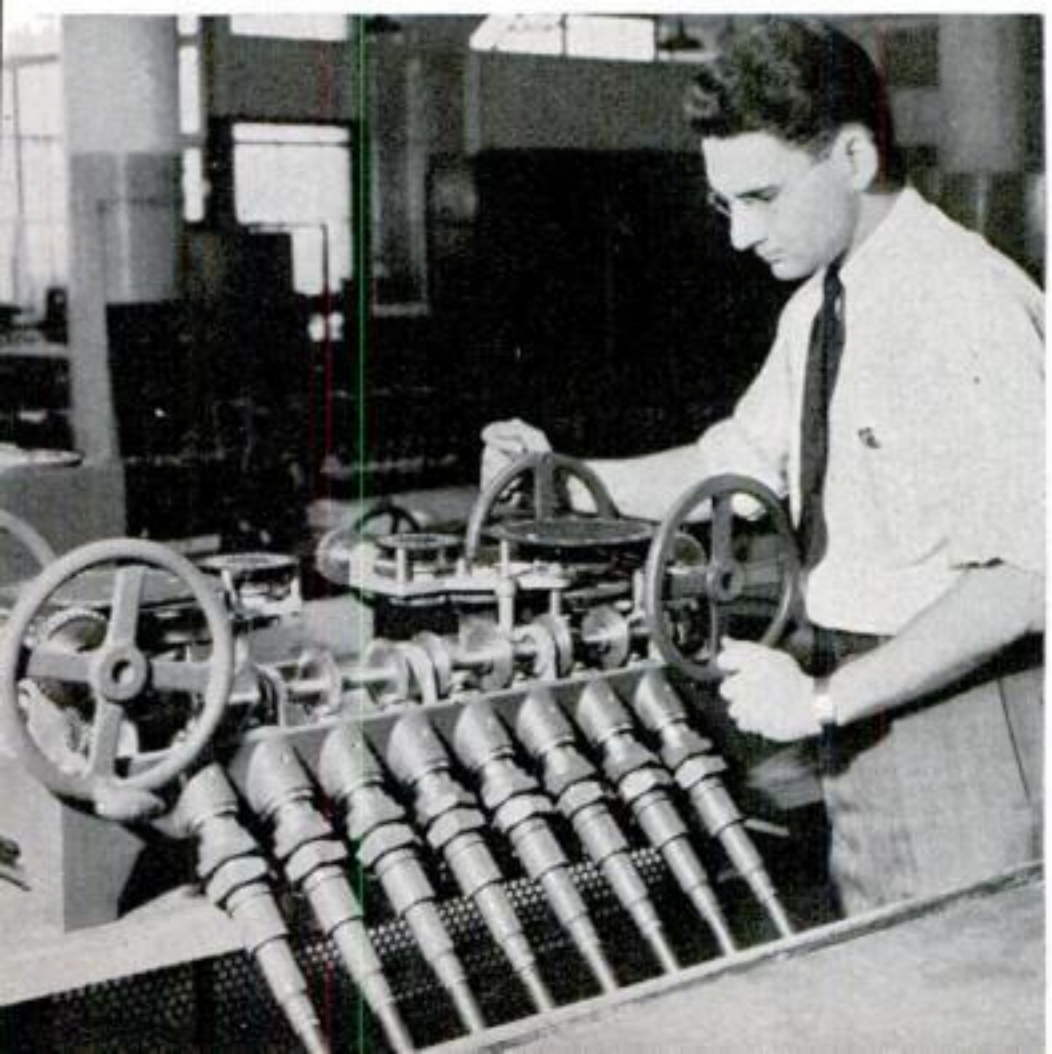
Curtailment of our tin supply, which comes from British Malaya and the Dutch East Indies, is also possible. But here again we have created a reserve to last a year with careful rationing. Meanwhile our South American neighbor, Bolivia, is providing us with 18,000 tons of ore per year. The greater part of the 90,000 tons of tin we import annually goes into the countless millions of tin cans used by the food-canning industry. New lacquer coatings for untinned sheet steel have proved adequate as a substitute on food containers. Glass is also available—as the farm wife well knows—as a substitute for tin cans, and at slightly higher cost silver could be used. It is estimated that the cost of a can of tomatoes would increase not more than three cents if packed in a silver-plated can—extra for engraving your initials, of course.

Since every metal-working machine must have efficient cutting tools, tungsten also has become a strategic raw material. High-speed tool steel requires 18 percent metallic tungsten to make it able to peel off red-hot steel chips without losing its temper. Most of the 500 tons of high-grade tungsten ore we import per year comes out over the long and tortuous Burma Road from the interior of China. This source may be cut off at any time, as it recently was when the Burma Road was closed temporarily. Our reserve supply is almost nil, aside from what high-speed steel scrap is in the hands of scrap-metal dealers and the steel mills. We have a five months' supply at best, but again fortunately we have a substitute. This is molybdenum. One mountain in Colorado can supply all the molybdenum we will ever need as a substitute for tungsten in high-speed steel.

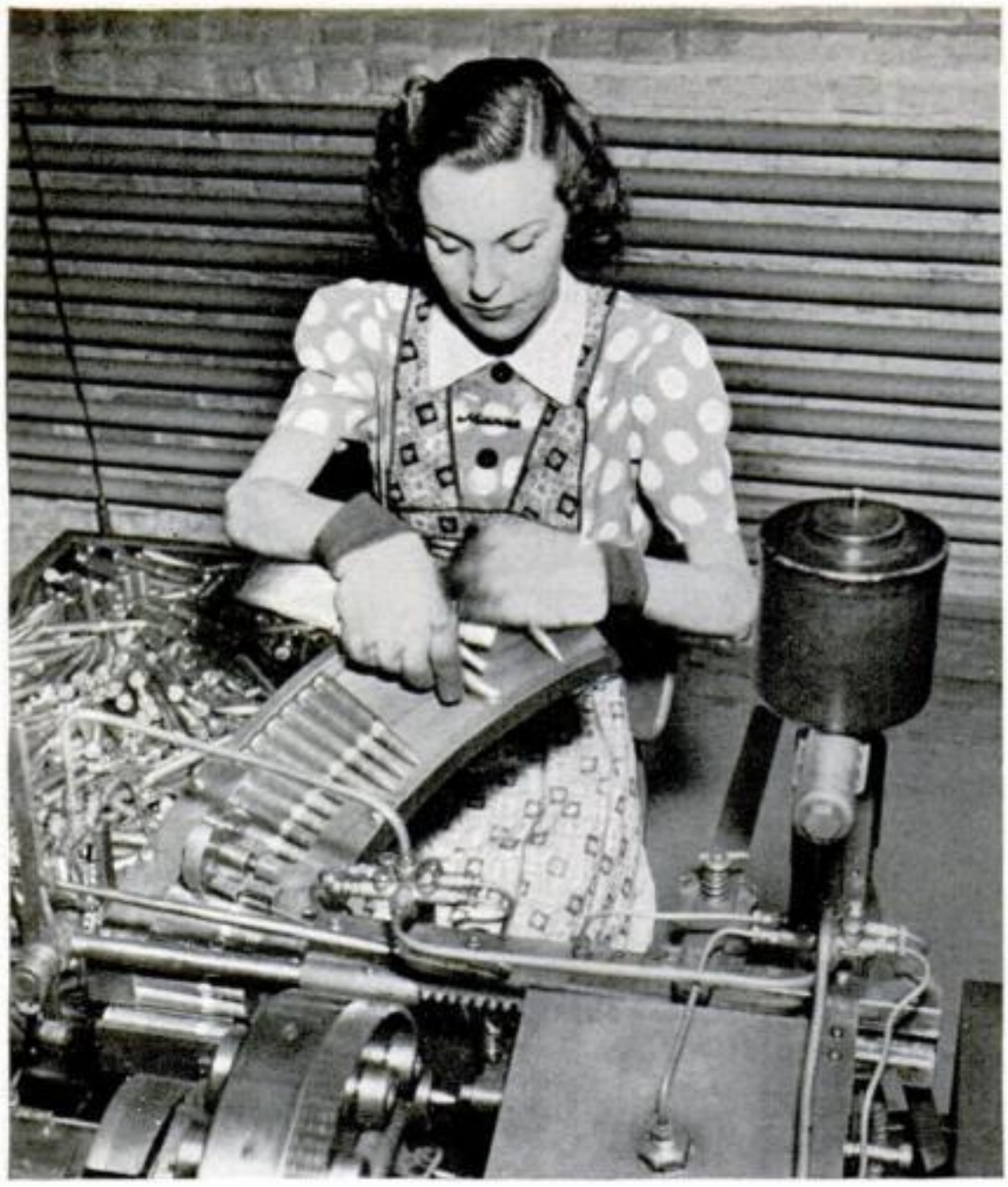
Another development of metallurgy has provided an even more efficient cutting metal than tungsten steel. This is tungsten carbide. Small bits of tungsten carbide when welded to less expensive steel shanks actually cut metal faster than 18-percent tungsten steel, and also hold an edge much longer between regrindings, thus saving at least 20 percent of the time a machine is idle while tools are changed. The really important feature of tungsten carbide, however, is the fact that one pound of tungsten carbide releases *100* pounds of precious metallic tungsten for the more essential defense needs—such as tips for armor-piercing shells.

Some 72 raw materials are essential to the national defense program, with now and then a material like magnesium—a metal lighter than aluminum and now being used in increasing quantities for airplane-motor castings—making the headlines for a day or two, only to be forgotten by the public as soon as it learns that a new magnesium plant just recently erected on the Gulf of Mexico is tapping the unlimited reserves of this metal in sea water! Zinc will be mentioned in connection with what agriculture is contributing in the way of raw materials for defense. There still remain to be mentioned antimony, industrial diamonds, manganese, nickel, beryllium—a new metal employed in hardening armor plate and for

The cry today is for skilled mechanics to build the precision instruments of modern war, such as this "synchronizer" for .50 caliber machine guns



. . . which automatically corrects the sights of as many as eight antiaircraft "chatterboxes" at once. Cables attached to outlets connect with the guns



Women also have a place in the defense program. And this job of gauging loaded .50 caliber machine-gun cartridges isn't one for jittery nerves. If a .50 caliber machine gun could be fired continuously for an hour, it would use $5,015 worth of ammunition —another reason why the bill for defense runs into the billions

machine-gun parts—cobalt, graphite, asbestos, cotton, mercury, and so on down through the list. In none of these materials could a serious shortage arise.

Of all defense raw materials obtained from distant foreign sources, "rubber" is the fighting word that would instantly send the United States battle fleet steaming westward with its decks cleared for action at the first authentic news that some enemy power was intercepting American merchant ships laden with crude rubber. Our annual consumption of crude rubber is something near 700,000 long tons, mostly imported from British Malaya and the Dutch East Indies. This supply may be cut off at any time.

Meanwhile the best minds studying the rubber problem are busy devising a second line of defense, should our supply of crude rubber from the Orient fail. Excellent synthetic rubber products are being made in limited quantities from petroleum and various gases in combination with other elements. Synthetic rubber production at present meets less than two percent of our minimum requirements, while 3,000 tons of guayule rubber, extracted from a shrub that grows wild in Mexico and our own Southwest, and about 20,000 tons from South America constitute our only other sources of crude rubber.

It is obvious that our rubber problem would be serious, if not critical, if it not were for the fact that in the junk yards of America and hanging from nails in almost every private garage, there are hundreds of thousands of tons of reclaimable rubber in discarded automobile tires. Chemical and mechanical processes now can extract this scrap rubber and restore it largely to its original state of usefulness.

Paul W. Litchfield, chairman of one of the largest rubber-processing plants in the world, estimates that from these garage nails and junk piles a two years' supply of vitally needed rubber can be reclaimed. Don't be surprised some day to hear a voice over your radio asking you to go out to the garage and unhook that old tire from the nail and turn it in as your personal contribution to the national defense program.

The defense rôle of chemurgy, the new science of converting farm products into industrial materials, is described elsewhere in this issue. From soybeans it makes plastics that will release much-needed zinc for the manufacture of cartridge-case brass. Soybean oil will yield stearic acid for use in the manufacture of tires and to increase the supply of glycerin for explosives. So the farm tractor may well be considered as enlisted for national defense, side by side with its tough big brother the 28-ton tank.

Machines and raw materials are vital to the national defense program. But it is manpower—the manipulation of machines and processes by skilled hands and intelligent brains—that must be counted on to build the complicated weapons we need.

Not much over two years ago a skilled mechanic over 40, unlucky enough to be out of a job, was considered all washed up and with no future but a pick-and-shovel job on a relief project. All that has been changed by the national defense program.

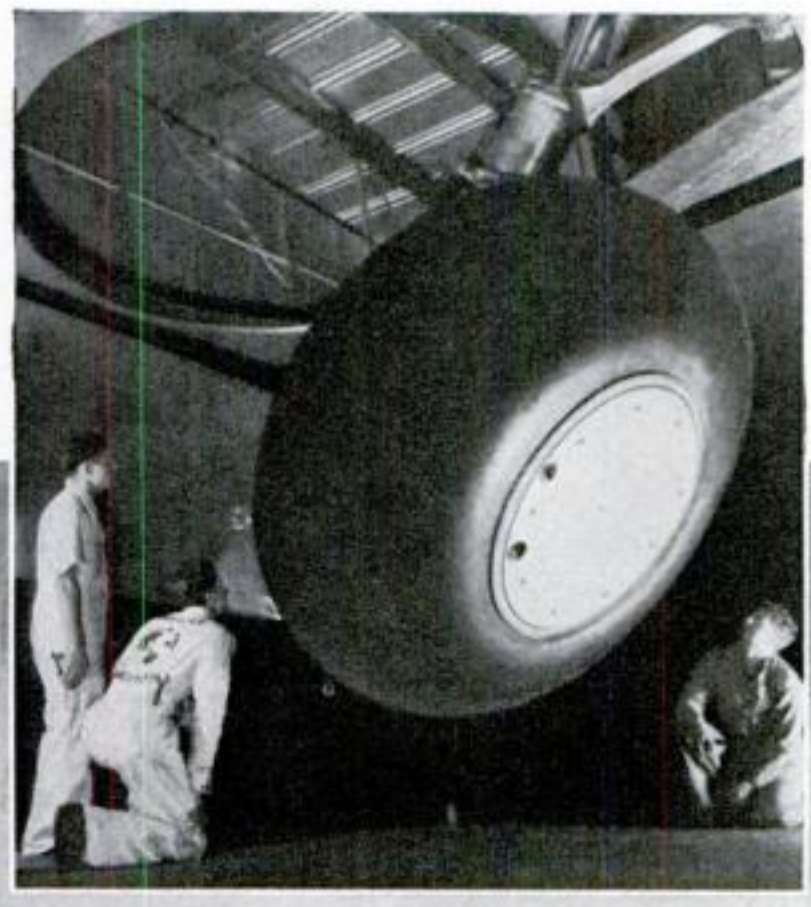
Recently the manager of a large saw

works producing lightweight armor plate for fighting planes pointed out to a visitor a giant plate-edging machine being run by a spry old man.

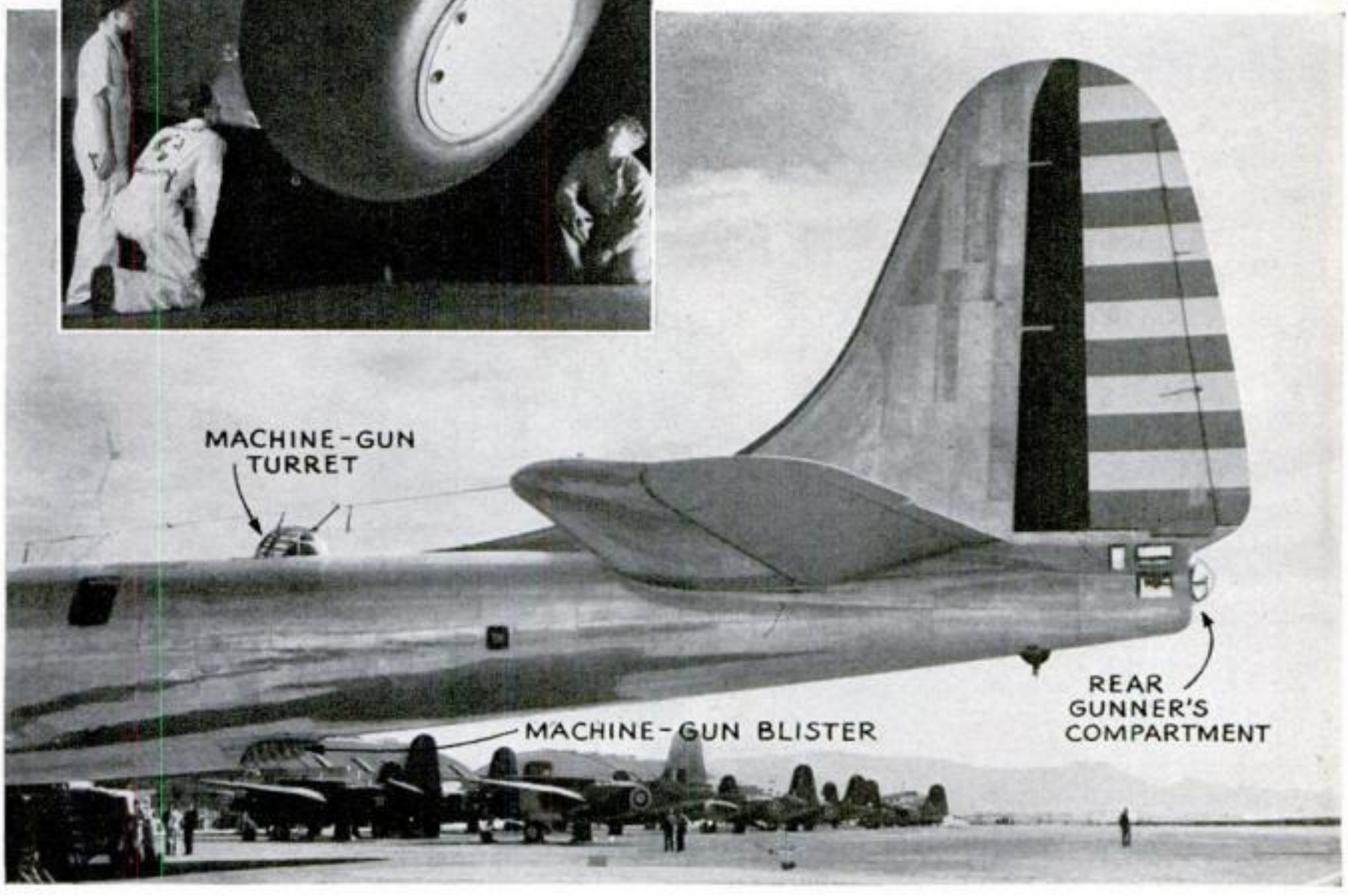
"We bought that machine secondhand because we couldn't get delivery of a new one in time," explained the manager. "But we got a bad scare when we discovered that not one of our 800 men knew beans about operating this monster. Then into our employment office walked a white-haired old mechanic who said he had been reading in the papers how the defense program needed all the machinists it could muster. Would we let a man of 75 show what he could do?"

The plant manager pointed to the old man on the big machine. "It sounds like a fairy tale, but our employment man played a hunch and took this old-timer out into the plant and showed him this machine. 'If you can make that balky thing walk the dog,' said our employment man, 'you're hired.'

"For a moment," went on the plant manager," the old man just stood there fighting back the tears. Then he said, 'Mister, ten years ago I was laid off because the factory



Symbol of America's growing air might, the world's biggest airplane roars down the runway on a taxiing test at Santa Monica, Calif. Built by Douglas for the Army, this 82-ton bundle of superlatives boasts the heaviest armament, the greatest load-carrying capacity, and the longest range ever put on wings. Men are dwarfed by one of her 24-ply landing-gear tires, shown in a retracting trial at left. Some of her bristling arsenal of cannon and machine guns are seen in the tail section below

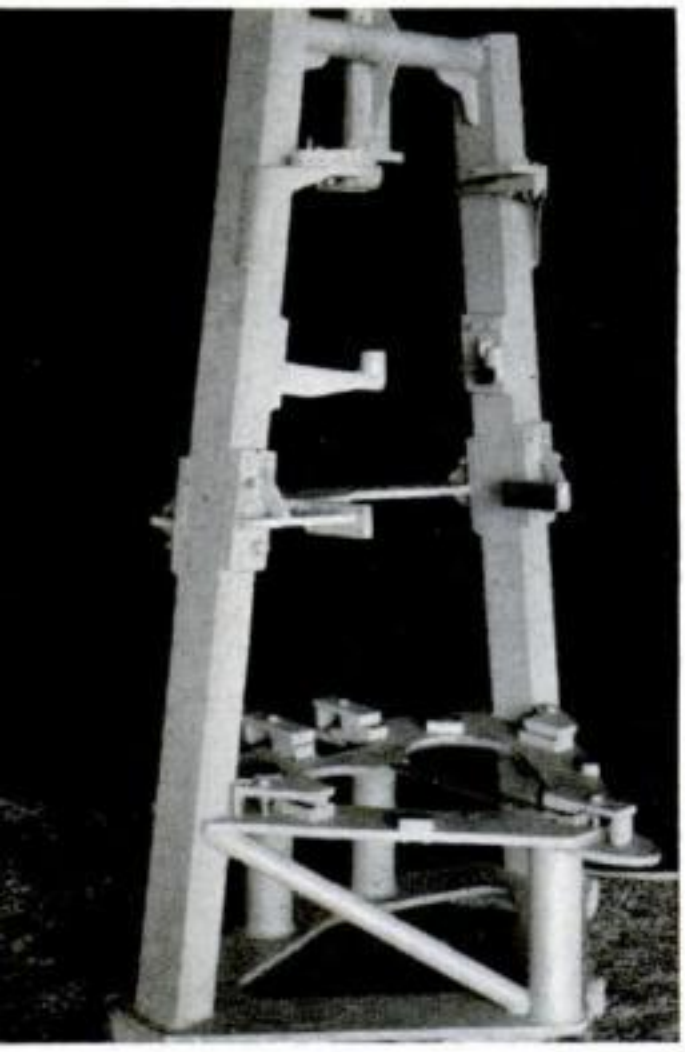


where I worked went bankrupt and sold off all its machinery at auction. That big machine, standing right there, is the one I used to run. Mister, I'll make that machine knit lace curtains if you say the word!' "

As more and more new machinery arrives and still more plants get rolling on mass production of defense materials the cry will be for more and still more skilled men. Otto W. Winter, chairman of the Emergency Training Committee, American Society of Tool Engineers reports: "Skilled labor and technical labor requirements reveal a shortage of 1,250,000 men."

Other surveys indicate that to meet the peak still to come an additional 4,000,000 skilled men will be needed. The training and morale of this vast army of defense workers is already recognized as being of equal importance and worthy of equal praise to that of the men in uniform. A nation of 130 million free people has spit on its hands and is tackling the problem of building an overwhelming stock of all the tools of war.

## TOOLMAKERS' JIGS SPEED PLANE PRODUCTION

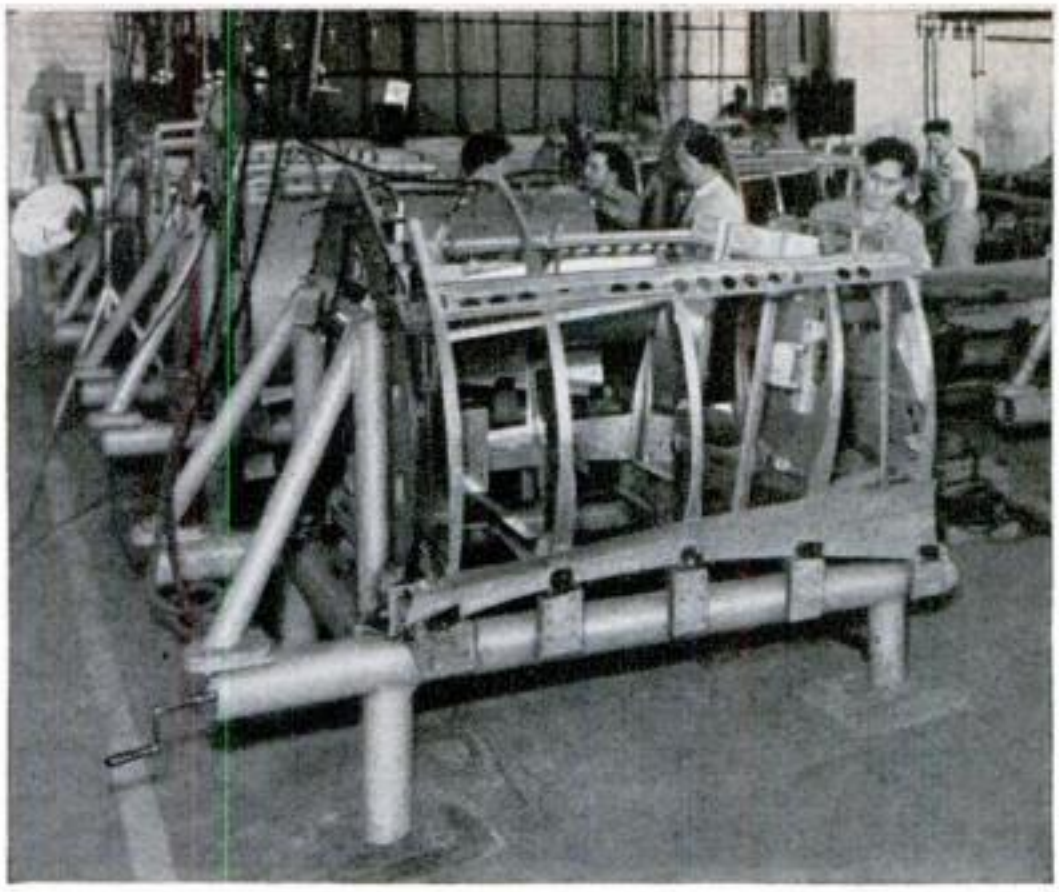


This is the sub-assembly jig for the tail fuselage of a Republic pursuit plane. It holds parts in place while the tail is assembled

Four bulkhead rings are attached to the jig and used to locate bridges. Circumferential stringers, tail surfaces, and wheel brackets go on, then the outer skin

The two halves of the mid-fuselage section are assembled on separate jigs. Here they are being spliced together up on end

. . . and here three sections—front, middle, and rear—are being joined to form the complete fuselage. Angle-iron brackets are mounted on the jig columns to form the attaching points. Note how the skin is staggered where it crosses the joints, to avoid creating weak spots at these critical points



Front fuselage section is assembled in this L-shaped jig. Fire-wall and frame rings, previously assembled on other jigs, are bolted in place. Then longerons, fore-and-aft framing members, are added to hold the motor at the fire wall. Brackets, flooring, and accessories are riveted in place. Finally the metal skin, with holes already drilled in the proper places, is put on the frame and riveted

Flat sheets for plane parts are cut in shears and sawed to approximate shape by band saws. Then they are clamped between templates of steel or wood and routed to shape on a vertical miller. The templates bear against guide rolls

## MAKING PLANES IN JIG TIME

JIGS are the tools which guide unskilled hands and enable them to do the work of experts. They are particularly important to the airplane industry, where rapid expansion to meet defense needs has created a demand for accurate mass production of millions of intricate parts, and there are not enough trained men to make them. Jigs, however, made by the comparatively few expert toolmakers, guide drills and hold spars, struts, ribs, and frames in proper relation to each other while they are fastened together. They make possible the whole system of sub-assemblies because, with them, workmen fresh out of a six-weeks training course can turn out thousands of finished parts, all just alike.

Below, a pursuit ship nears the end of Republic's assembly line. At every stage of its construction, component parts have been assembled with the aid of jigs which enable comparatively inexperienced men to do the work, freeing more skilled hands for jobs which they alone can do. One of these jobs is the making of the jigs themselves, so that one expert mechanic can guide the hands of hundreds of willing but unpracticed youngsters at the same time

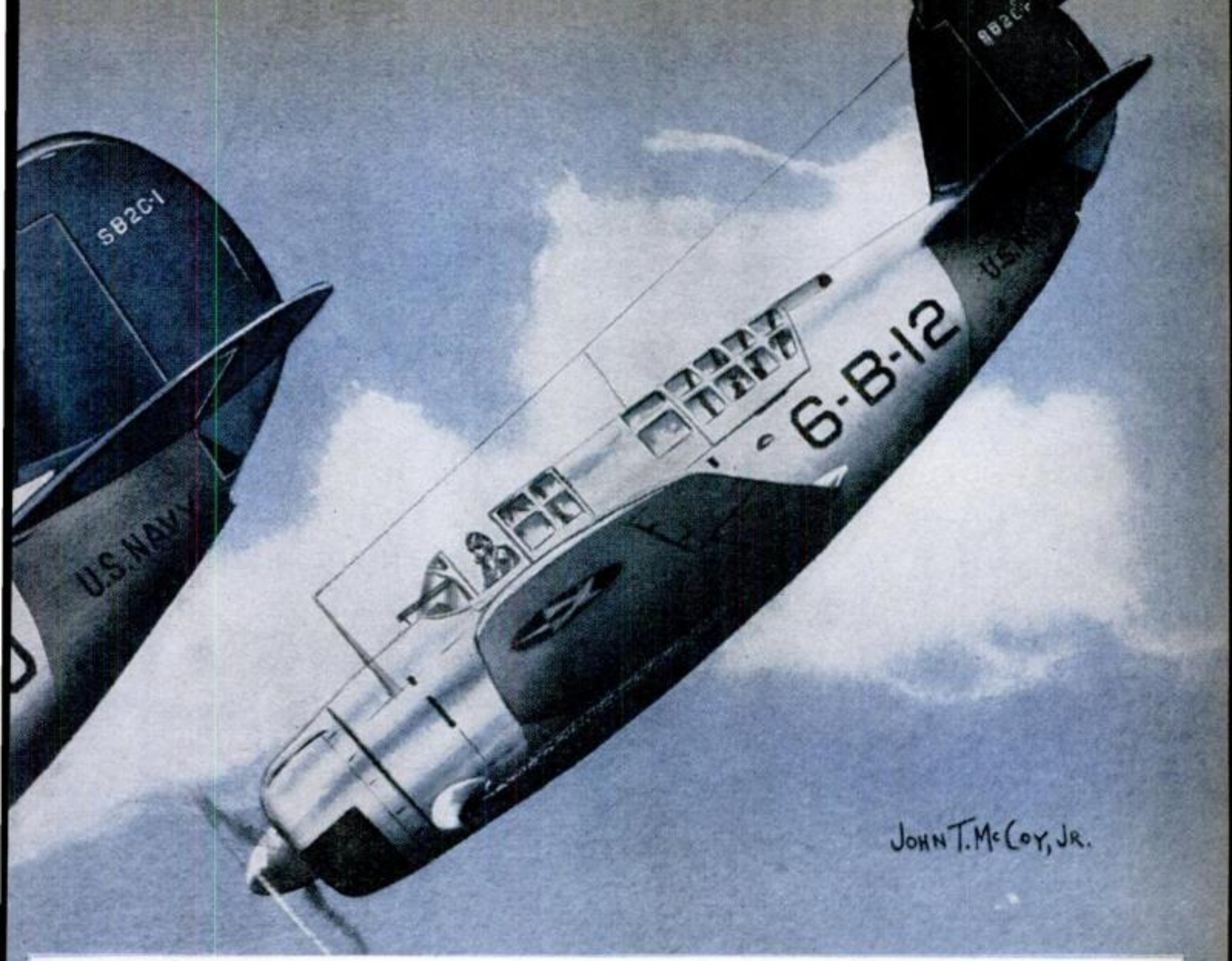
AMERICA ROLLS OUT

# The Warplanes

BY C.B. ALLEN

DIVE BOMBERS FOR ARMY STRENGTH—

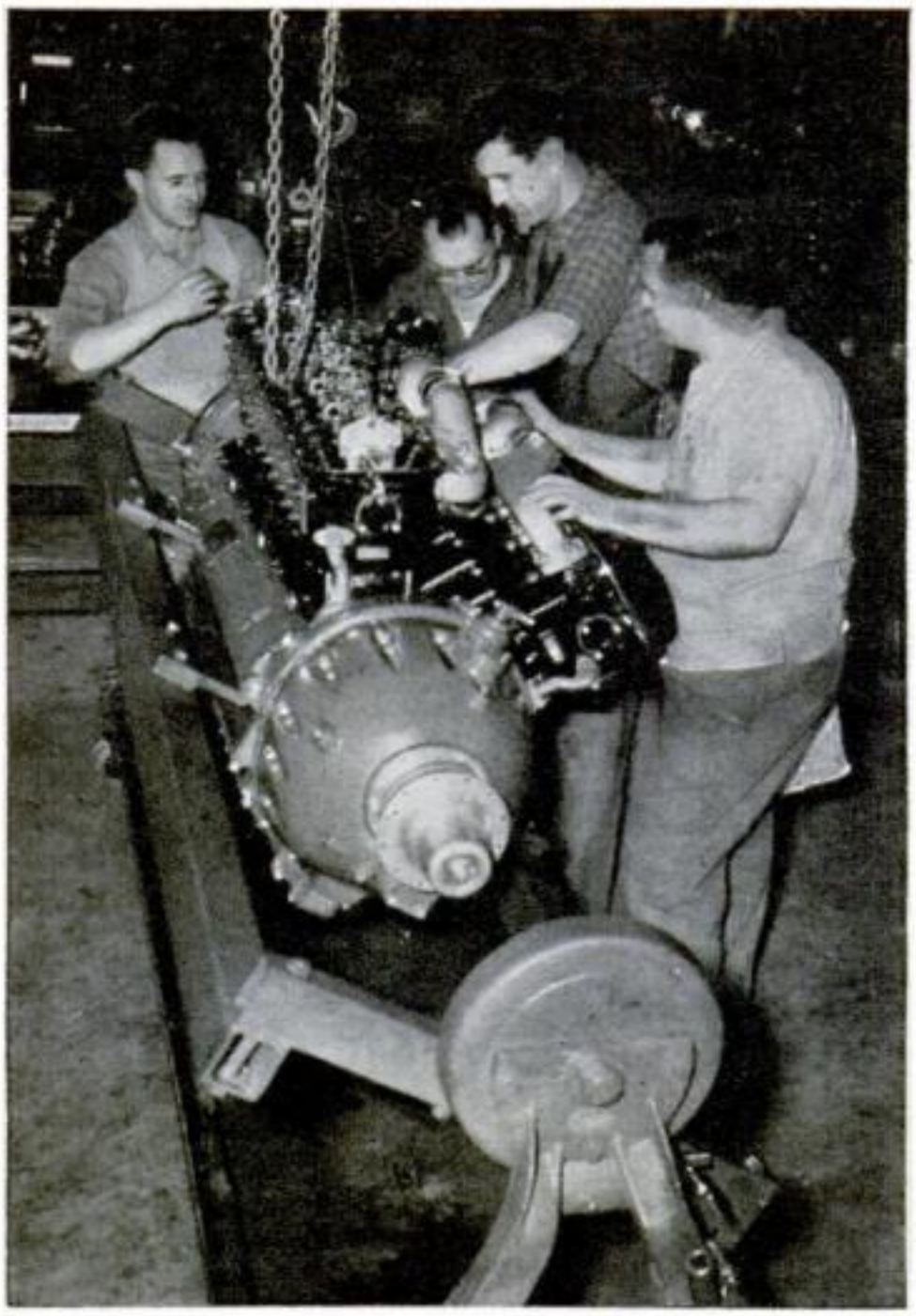
The Curtiss SB2CI (above) is the Navy favorite. It is 100 m.p.h. faster than older models. It carries twice as many bombs. The Army wants swarms of these hell divers to extend its fire power beyond the range of its longest guns




MILITARY-AIRCRAFT production in the United States has really begun to go to town in the last few months. It still has a long way to go, if it is ever to reach the 50,000 to 80,000-airplanes-a-year output confidently predicted from time to time. But it is unmistakably under way and is constantly gathering both volume and momentum. In the parlance of flying men, America's airplane factories are "rolling out the tinware," at an almost incredible rate considering the few months that have elapsed since the Government gave them the go-ahead signal.

Heavy, four-engined land-plane bombers for Britain and the United States, that once took weeks and months to build, and equally long-range flying-boat patrol bombers, are coming off the assembly line at the rate of two a day or better. Shorter-range medium bombers and still smaller and more maneuverable attack bombers—both in the two-engine category—are being built at three or four times this speed. Single-engined fighters and deadly dive bombers are being turned out with even greater rapidity, while training planes of the primary, basic, and advanced types are being produced in quantities that, figuratively speaking, warrant their being wrapped up in bundles and delivered to their purchasers in dozen lots.

Periodic surveys made by the Aeronautical Chamber of Commerce illustrate the gains made in American warplane production since the Government ironed out the problems of plant expansion, taxes, and amortization and began placing orders late last summer and last fall. During November the industry turned out 700 military planes. In December its output rose to 800; in January it was 1,000; in March, 1,200; and in April, 1,427. Col. John H. Jouett, president of the Aeronautical Chamber, predicted some time ago that a total of 18,000 planes would be produced during 1941, with 30,000, under present programs, rolling off the assembly line in 1942. He said America already was coming "very near" the estimated British and German pro-



Workmen tearing down a 1,000-horsepower Allison liquid-cooled engine for inspection after a test run. The 12 cylinders of this engine are arranged in two banks of six cylinders each, driving a single crankshaft. Ready for production is a 2,000-horsepower Allison engine of 24 cylinders in four banks and driving two crankshafts

Allison engines power the three fighter planes on which the Army places its chief reliance. This is the single-engine Curtiss P-40 pursuit

Two Allisons drive the Lockheed P-38 as fast as 458 miles an hour. Originally a one-place ship, it is now built to take a crew of two

The Bell P-39 pursuit-interceptor (Airacobra) now has armor protection and leakproof fuel tanks. It carries a 37-mm. propeller-hub cannon and six .50 and .30 caliber machine guns

duction rates of 1,500 planes a month each.

By the end of 1943, it is now estimated the U. S. will be producing 3,600 planes of all categories every month. This will also mean 9,000 engines and propellers monthly. Some idea of the expansion needed to reach that capacity may be gained from the fact that in the eight months preceding March 1, 1941, the industry's floor space increased 82 percent — to 31,383,967 square feet — while its total number of employees increased 88 percent to 226,172. And we have another 2½ years before we attain the objective set before us.

The task actually assigned to this country's aircraft industry by defense officials is to build a total of approximately 44,000 warplanes, including everything from trainers to four-engined "flying fortresses" by July 1, 1942. Of these, 16,500 are for the Army, 8,500 for the Navy, more than 15,000 for the British, including Canada, and 3,600 two-engine and four-engine bombers to be built under the Knudsen plan of enlisting automotive facilities for the production of aircraft. The allocations indicated here have become largely academic since passage of the lease-lend act; as a matter of fact, reliable sources in the aircraft industry report that at one time about 90 percent of this country's warplane production was going to the British.

In view of frequent assertions, some of them from high places in the Government, that aircraft production in the national defense program has been "lagging," it is interesting to know what the industry, through its spokesman, Colonel Jouett, has had to say for itself. After recapitulating the ever-increasing number of warplanes which American manufacturers have been called on to build, Colonel Jouett, in one of his recent "progress reports" to the public, said this:

"The immensity of the job can be realized when I tell you that in 1939 the industry did $225,000,000 worth of business; in 1940 our people increased their output to $544,-

000,000, at the same time carrying on a tremendous plant expansion, and that this year we hope to turn out $1,500,000,000 worth of airplanes."

There are exceptions, of course, but, on the whole, the industry maintains that it is exceeding by a comfortable margin its own aircraft-production promises—which it differentiates sharply from the wishful-thinking "production schedules" bandied about by politicians. It is confident of its ability to turn out the 44,000 warplanes it has promised to build by the middle of next year, but it has an understandable resentment of seeming to be committed (by somebody else) to a 50,000 or an 80,000-airplane program—and thereby being put on a spot with the public when it produces *only* what it has undertaken to produce.

The industry is proud of the fact that, after carefully surveying its facilities at the beginning of 1939 and telling the Government it could produce 5,500 military planes a year, it actually delivered 5,800 ships in 1940, Congress having approved such a construction program a few months before the war began. At the time of the survey, the industry's total output was about 200 military planes a month—and its production had doubled in the preceding year!

Most famous of the Army's heavy long-range bombers is the Boeing B-17D, latest version of the four-engined "flying fortress." It is now being turned out ahead of scheduled delivery dates at Seattle

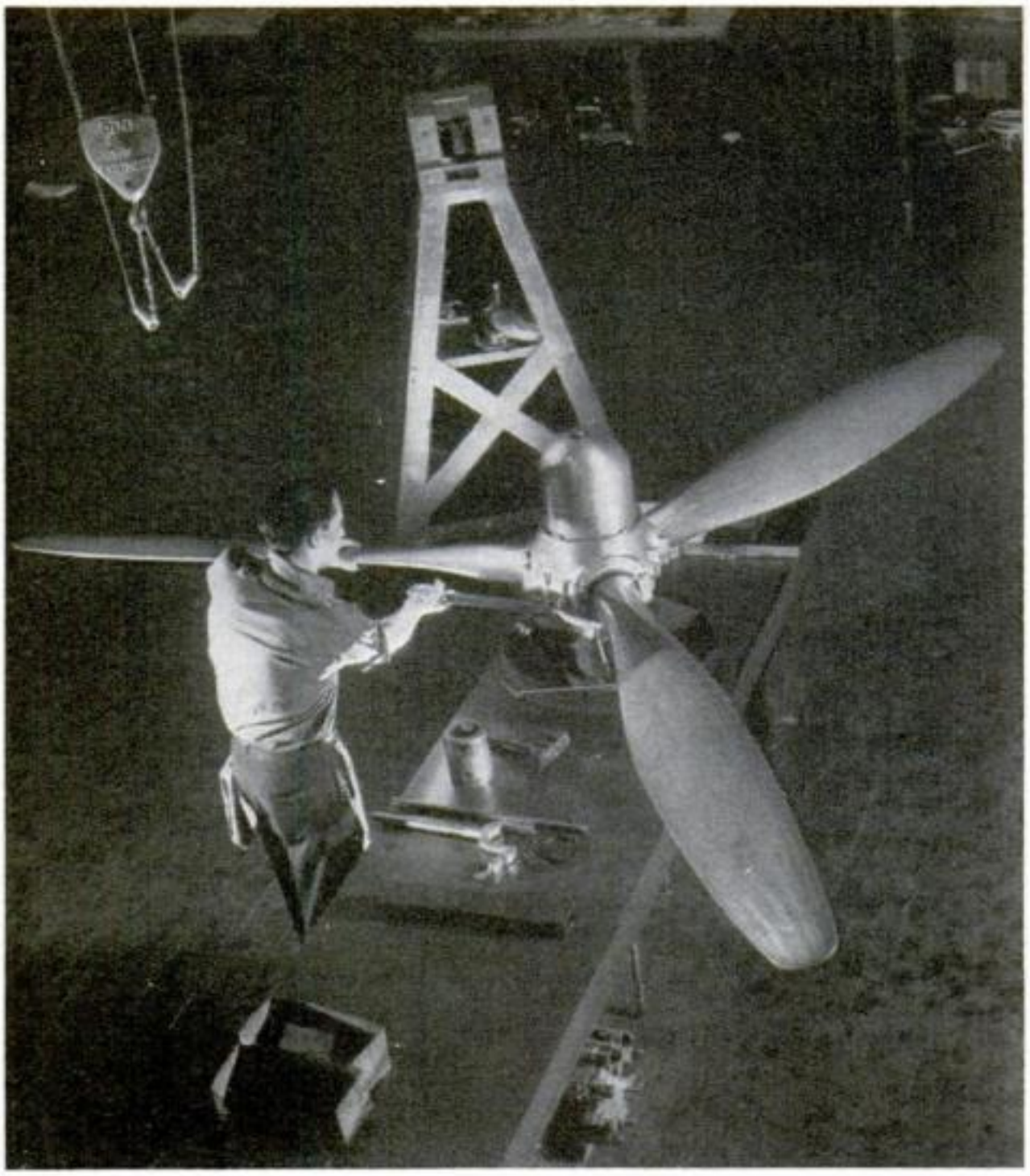
In the medium-bomber class is the twin-engined North American B-25, one of the bomber types to be assembled in Government-built plants from parts manufactured in semifinished form by automobile makers

Another medium bomber, the Martin B-26. A semi-high-wing design with tricycle landing gear, it is powered by two 18-cylinder, 2,000 horsepower Pratt & Whitney engines and uses four-bladed propellers

A light attack-bomber, the Douglas A-20. Powered by two Wright 14-cylinder radial engines, it carries a crew of three. Sub-assemblies for this plane are being fabricated at Detroit automotive factories

Between the outbreak of the European conflict in September, 1939, and July, 1940, when this Government offered the industry financial help in the plant-expansion program required to increase production, America's aircraft manufacturers themselves already had spent $52,000,000 for new factories and equipment, though they estimated that only $11,000,000 worth of it will be needed after the present emergency is over. This phase of the industry's expansion program, of course, was stimulated by warplane and warplane-engine orders from the French and British in their belated effort to overcome the numerical and technical superiority of the Nazi air force. Through it, the country gained not only valuable additional facilities for the production of aircraft but priceless experience in the always difficult task of building and equipping new plants and training personnel to operate them without interrupting the flow of existing production.

Much has been said about the automotive industry's contribution to the American warplane production program. It is, of course, an important factor and promises



Assembling a three-bladed propeller. Manufacturing the modern hydromatic prop, which automatically adjusts its pitch according to load, requires great precision, as shown in pictures on the opposite page, made at the Hamilton Standard factory. Nash-Kelvinator also makes them under license

to become increasingly so as time and the country's leaders take it on into an uncertain future.

Less than 10 percent of the machine tools used in automobile plants are said to be immediately adaptable to manufacture of the airplane itself—a relatively simple production problem compared with that of an airplane engine. That is why the Ford Motor Company, with its genius in tooling and production, started from scratch when it agreed to produce 4,000 Pratt & Whitney 1,850 and 2,000-horsepower radial, air-cooled engines, under a dollar-an-engine licensing agreement, and built a brand-new factory, equipped throughout with new machine tools.

Ford, having also undertaken to fabricate fuselage, tail surface, and wing sub-assemblies of four-motored Consolidated B-24 bombers, in the so-called Knudsen plan to augment warplane production, also is erecting another new factory specifically designed for this job near Ypsilanti, Mich.

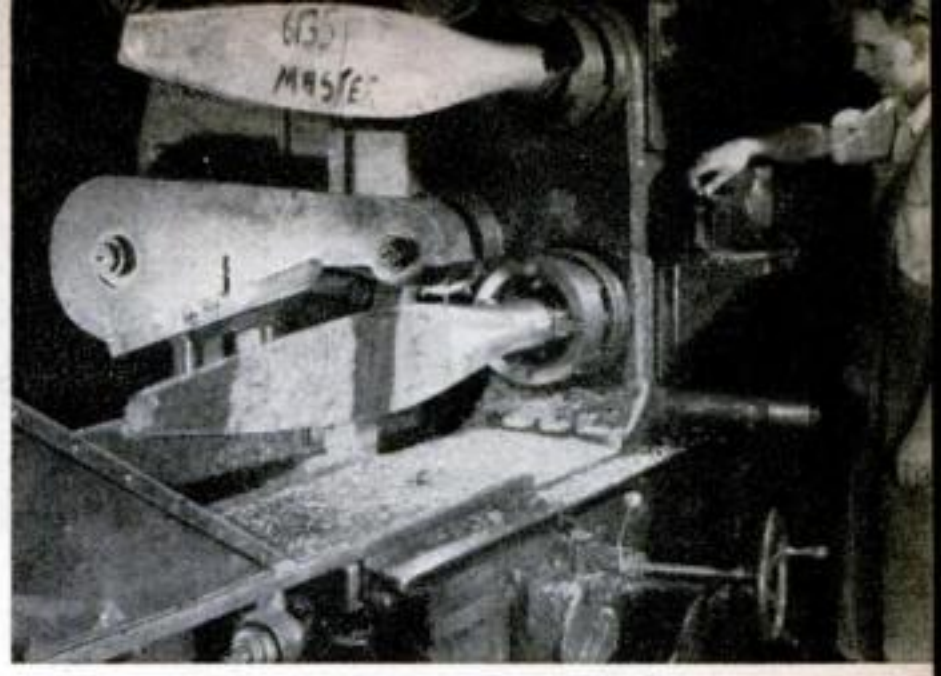
Under the Knudsen plan, bombers turned out in semi-finished form by Ford and other automobile manufacturers will be put together and equipped with engines in four huge Government-built assembly plants that are now under construction at Omaha, Kansas City, Tulsa, and Fort Worth.

This automotive-aircraft production scheme is still to reach its peak, so far as output of finished bombers is concerned. But there is little doubt in the aircraft industry, which has been called on for supervisory personnel to run the final assembly plants, that the plan will contribute materially to the country's warplane production. In addition to long-range, four-engined Consolidated heavy bombers, these plants are scheduled to turn out twin-engined Martin B-26 and North American B-25 medium bombers, supplementing the regular factory output of these three ships in California and Maryland.

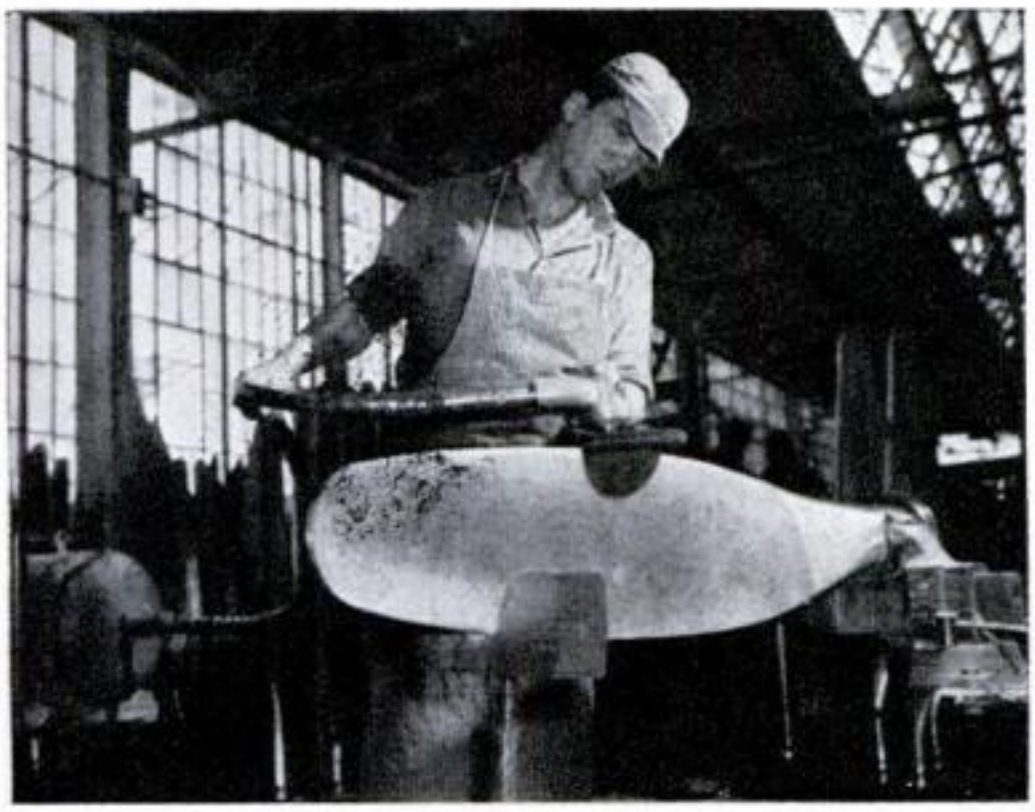
Because of the Government's recent new accent on heavy-bomber production, ten factories are scheduled now to produce four-engined bombers, of which 1,100 are now on order. Douglas, Consolidated, and Boeing will each operate two, while Ford, Martin, North American, and Lockheed will have one apiece. The combined output of these ten plants is expected to aggregate 500 monthly, or 6,000 annually, in about a year.

With the B-25 and the B-26, to say nothing of the Consolidated B-24, already coming off their home-town production lines in substantial quantities, and the modernized version of the original B-17, four-motored "flying fortress" being turned out ahead of scheduled delivery dates at Seattle, the United States is rapidly achieving a well-rounded program of long and short-range, land-based air striking power. In the field of water-borne aircraft, the Navy is looking after its own long-range bombardment and

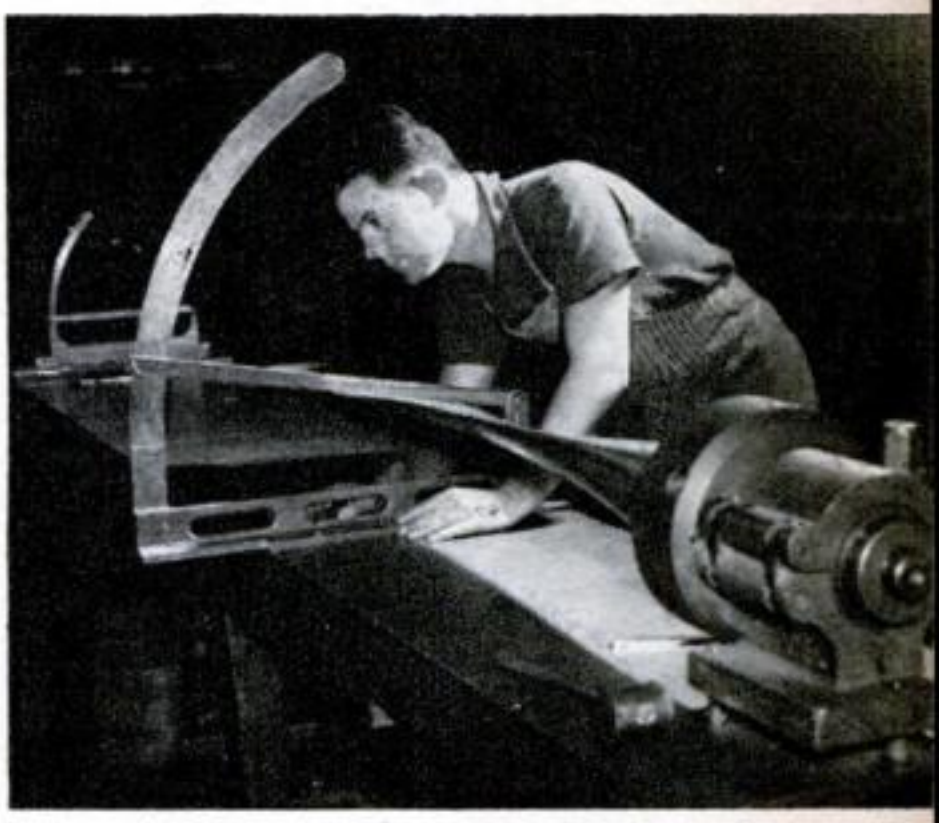
**The blank for a propeller blade is given the right amount of twist in a machine. Work must be accurate to one tenth of a degree. Thick spots are marked for subsequent cutting . . .**



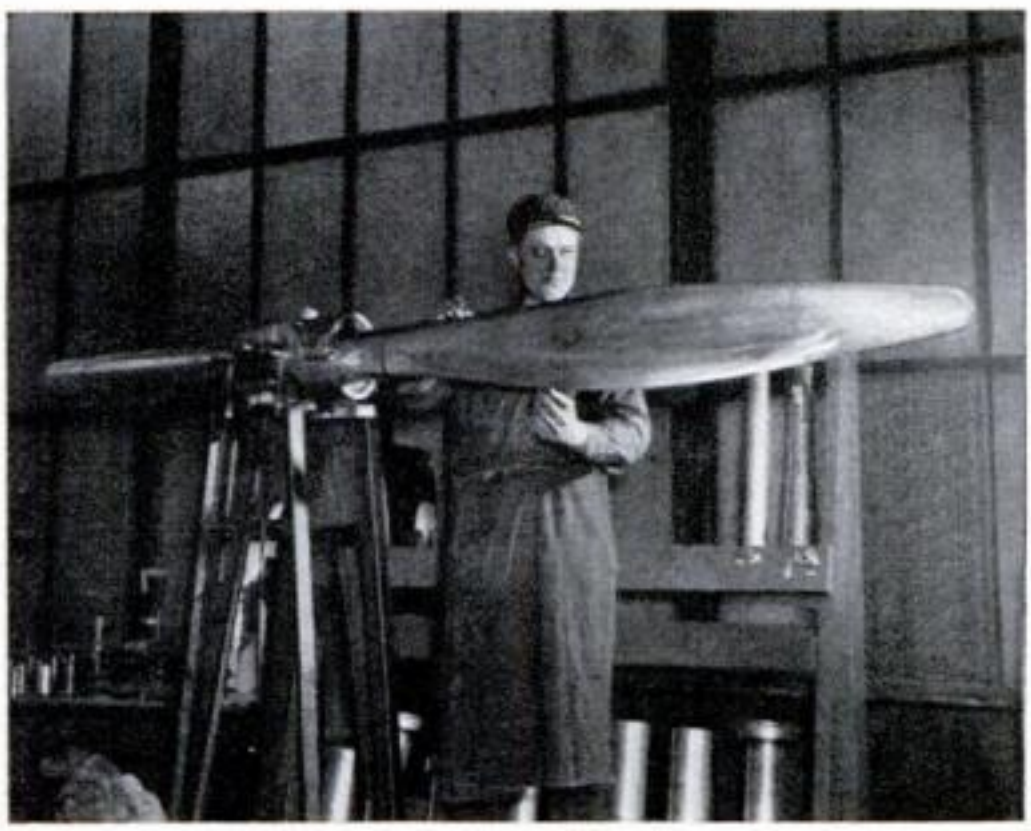
**. . . and the blade goes to a duplicating machine, which cuts down the inner 21 inches of the radius to match a master pattern. Tolerance is .035 inch**



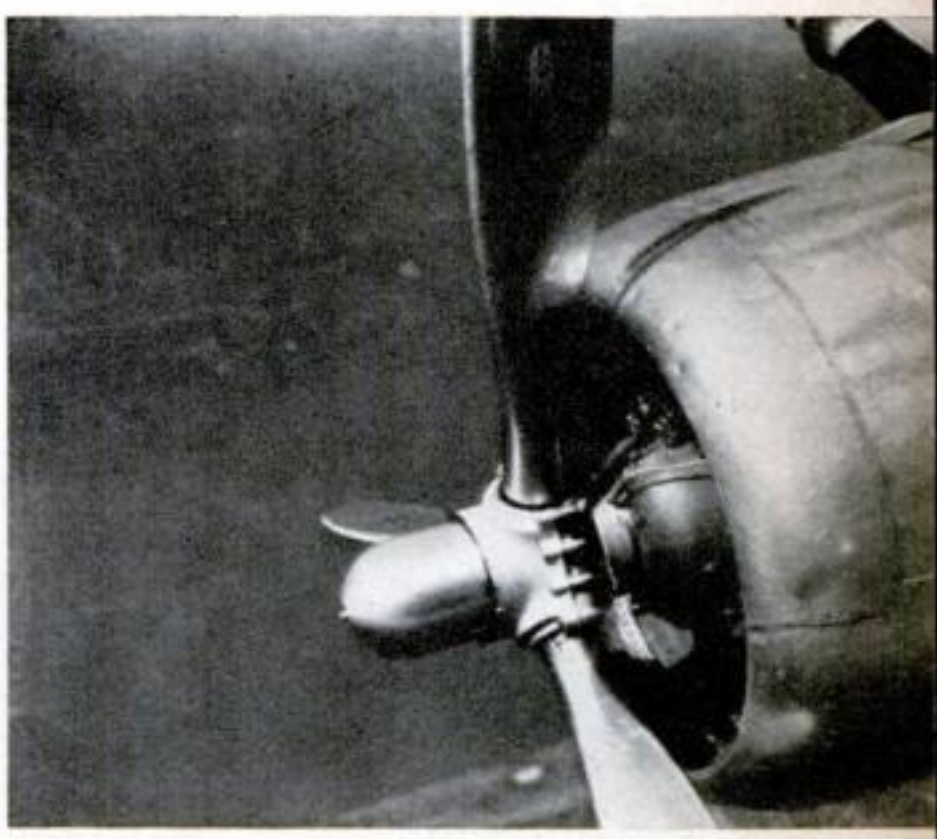
**After the outer radius has been cut to the same tolerance on a profiling machine, this worker grinds the shape or "planform" of the blade until its dimensions are correct. Now the blade is ready for exhaustive checking and tests**



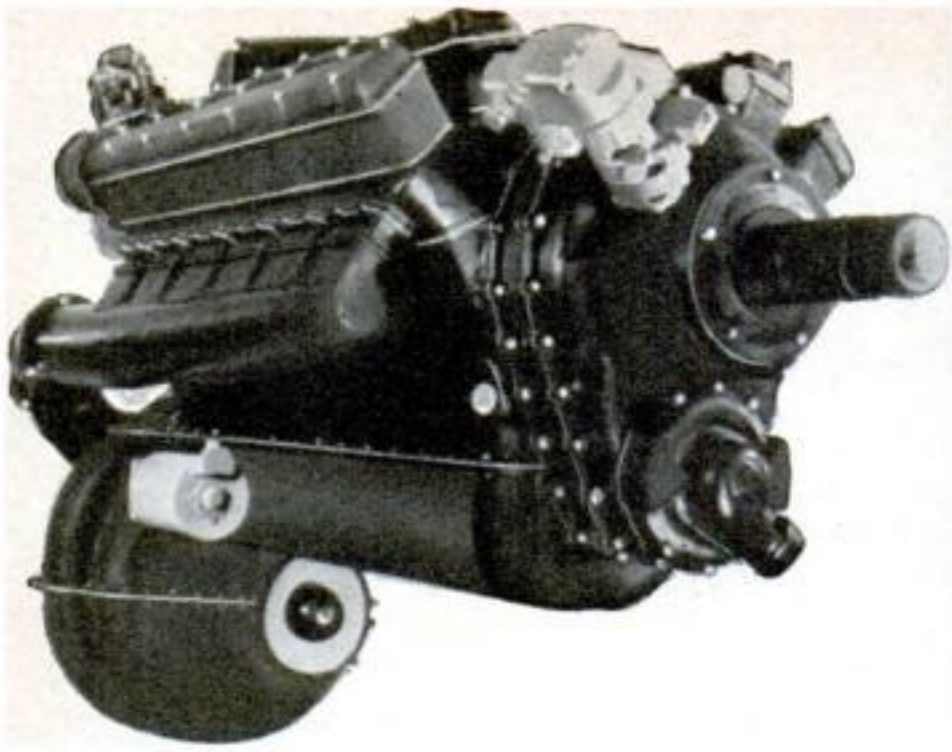
**Next comes the delicate job of checking the angles and surfaces of the finished blade. Angles are measured between "stations" at six-inch intervals from what would be the center of the drive shaft**

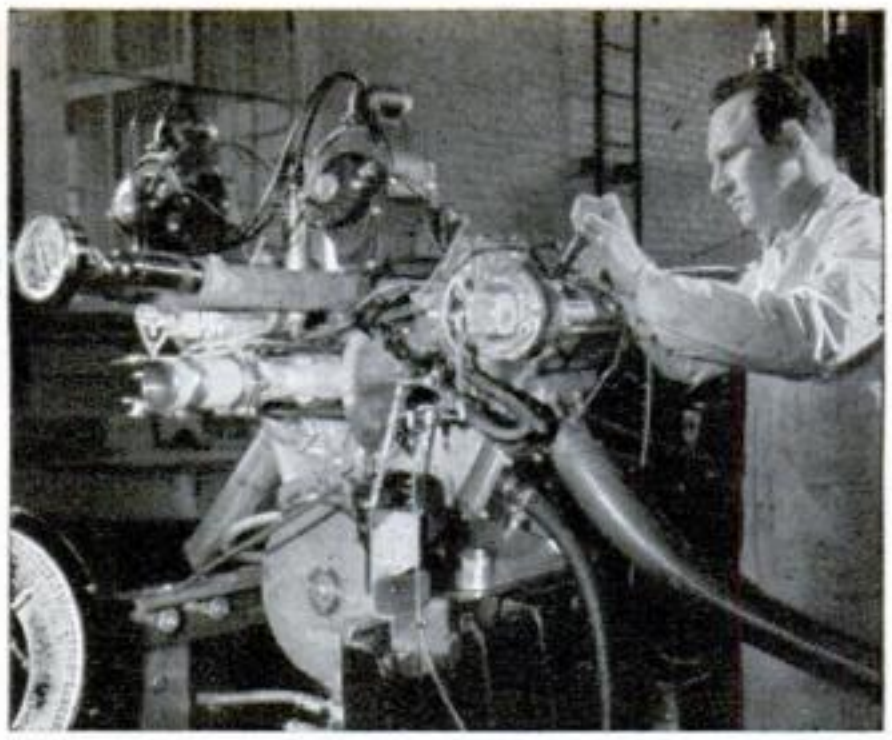


**To obtain perfect balance, the blade is weighed against a "master cylinder" and its weight is corrected by placing small bits of lead wool in spots where they can be plugged into holes with cork. For accuracy, the cork is weighed too**

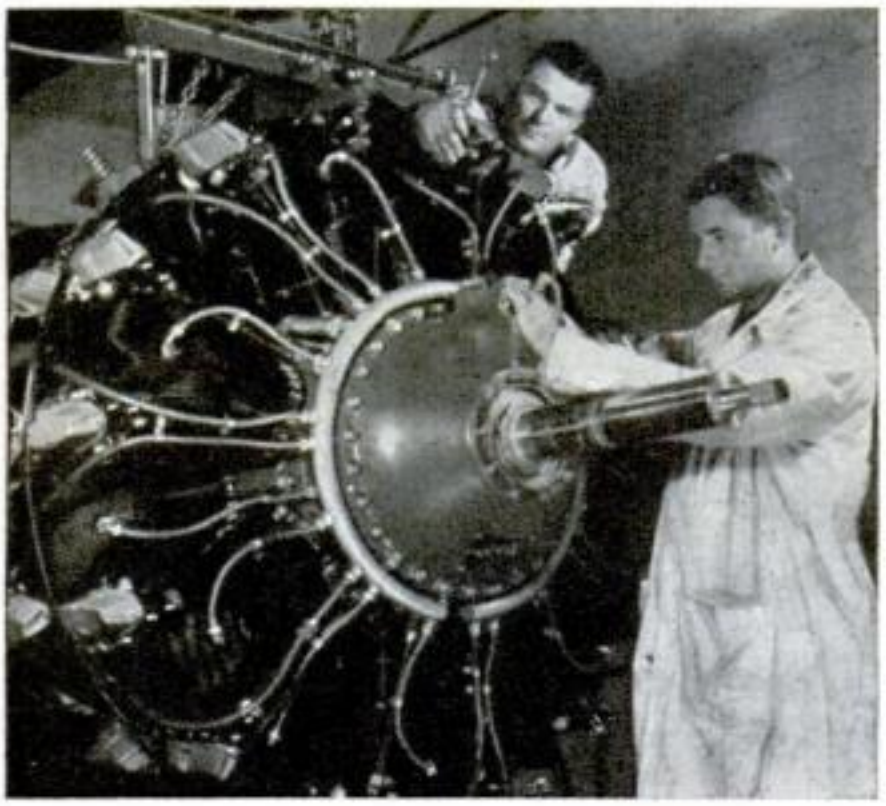


**And here is a three-bladed propeller in operation. Full-feathering action makes it possible to turn the blades squarely into the airstream in case of engine failure, to reduce the drag**

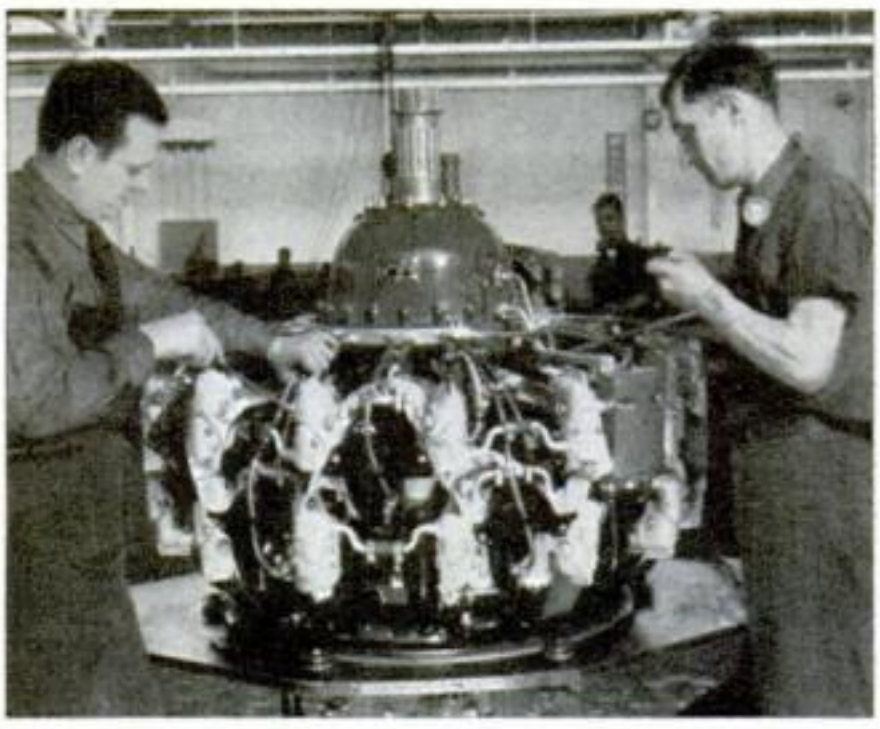




With this two-cylinder experimental model, Ford engineers are ironing out the problems of building a 12-cylinder in-line liquid-cooled engine with fuel injection and exhaust-driven supercharger. A wooden mock-up of the 1,500 to 1,700-horsepower job is seen at upper left. Its production will be speeded by a new process of centrifugal casting



Supplementing production at five Wright plants in Paterson, N. J., and a new one in Cincinnati, Ohio, Studebaker is building $33,000,000 worth of 1,700-horsepower Cyclone engines in South Bend, Ind.



Buick's new airplane-engine plant at Chicago is filling a $36,000,000 order for 1,200-horsepower Pratt & Whitney Twin Wasp engines, with allowance of $31,000,000 for plant and $6,600,000 for equipment. Pratt & Whitney get a royalty of $1 a motor

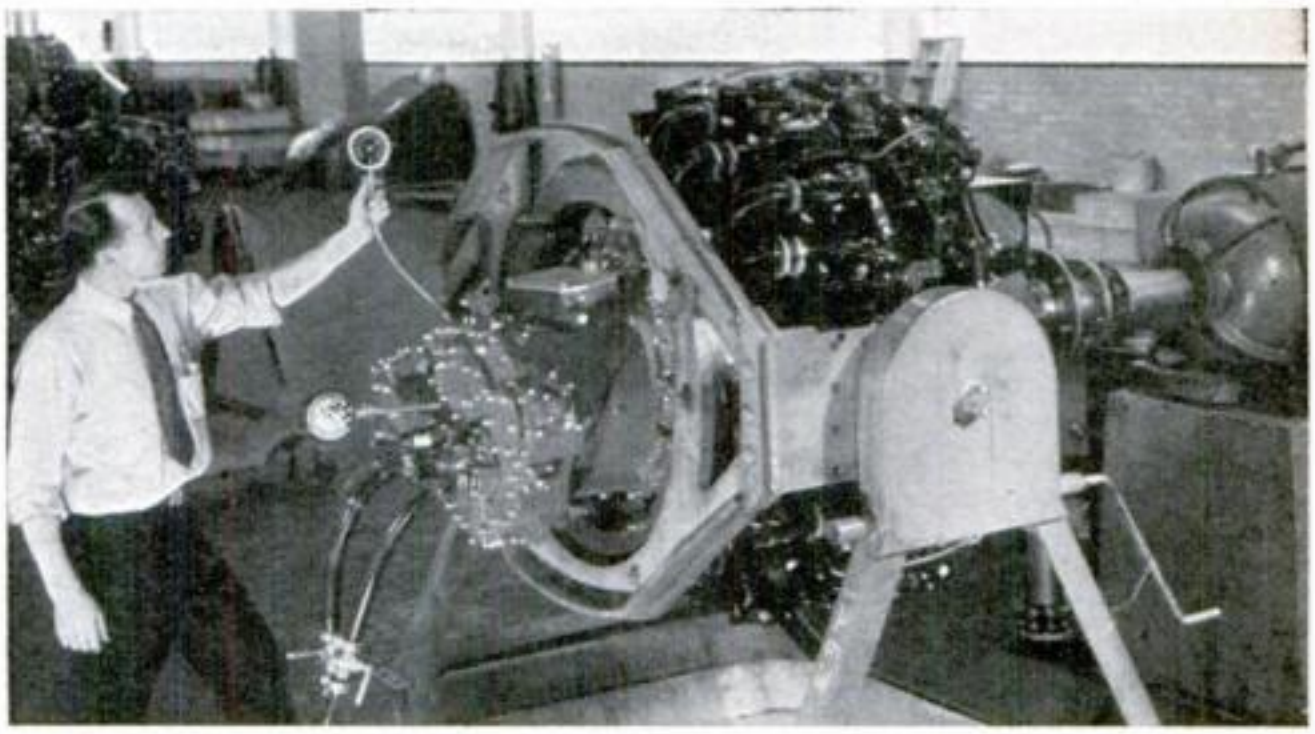
scouting needs with the procurement of twin-engined PBM-1 Martin flying boats and four-engined PB-2-Y "air dreadnoughts."

In addition to the production of long and medium-range bombers, the Army is now receiving substantial numbers of lighter and more maneuverable attack bombers, such as the Douglas A-20 series which is an American development of the famous DB-7 bombers built first for the French and now for the British. Sub-assemblies for the A-20, incidentally, are being fabricated in Detroit's automotive plants but this is being done under contracts foresightedly negotiated by the Douglas company itself, which have nothing to do with the "Knudsen plan" of producing 3,600 medium and heavy bombers by the end of 1942. Douglas also is turning out large numbers of SB-D dive bombers for the Navy and Marine Corps; and the Army, abandoning its former lack of interest in this type of craft as a result of the exploits of Germany's Stukas, also is one of Douglas' dive-bomber customers. Other concerns currently producing their own deadly versions of this single-engine type of bomber include Vultee, Brewster, and Curtiss.

The latter firm is best known for its famous Allison-motored P-40 pursuit plane, which has been rolling off the assembly lines at its Buffalo plant in quantity production for months to bolster the air defenses of England and replace obsolete equipment of our own Army Air Corps. More recently, the Air Corps has been receiving, also from Buffalo, the faster and more formidable Bell P-39 Airacobra, a tricycle-landing-gear pursuit ship in which

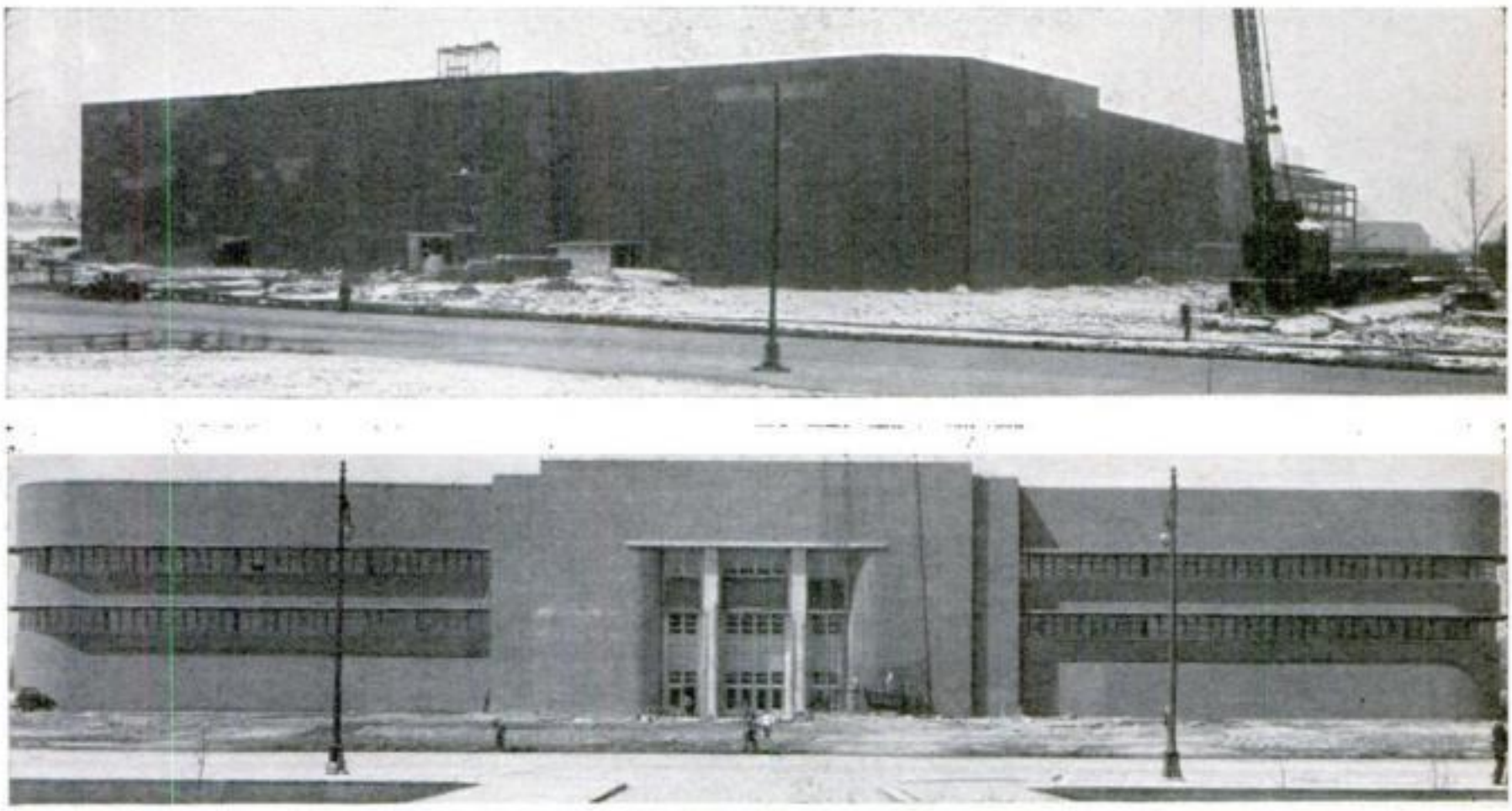
the "submerged" Allison engine is located behind the pilot, driving the propeller through an extension shaft extending along the bottom of the cockpit to the plane's nose. In California, Lockheed has begun production of its twin-engined (Allison) P-38 pursuit after making thousands of engineering changes in the original design.

Both Pratt & Whitney and Wright, the principal aircraft-engine suppliers of America, have produced air-cooled radial engines developing 2,000 horsepower or more. It is no secret, and possibly significant of future trends, that the Army is now sponsoring several pursuit planes designed around the radial power plants which had been relegated to *(Continued on page 204)*



Ford is building 4,236 Pratt & Whitney 18-cylinder double-row radial engines, from 1,850 to 2,000 horsepower, also under a $1 royalty arrangement. Peak production will be 15 a day

Another Ford defense activity will be the fabricating of fuselage, tail surface, and wing sub-assemblies for Consolidated B-24 bombers at a new plant near Ypsilanti, Mich. With superchargers, the B-24 can climb to seven miles, fly 300 miles an hour in the substratosphere, carry tons of bombs 3,000 miles



Building a factory inside a box was the novel method used to speed completion of Ford's new $21,000,000 airplane-engine plant at River Rouge. So that winter weather would not delay work, a temporary shelter of 900,000 square feet of fiber board was erected over walls and roof after steel work was done

# Motorization and Mechanization

## HELP THE ARMY MOVE FASTER AND HIT HARDER

By DAVID M. STEARNS

MODERN armies must have speed to win battles. They must be able to move quickly from one place to another, to fight on the run as well as in the trenches, and to maintain a fast-moving stream of supplies to front lines. To do all that, they need motor vehicles by the thousands.

The U. S. Army is no exception. Already it has close to 200,000 of the vehicles it needs, and more are being put to work as fast as they can be made. They range from motor cycles and "bantam" cars to 28-ton tanks and giant high-speed tractors for hauling 15-ton guns.

Army men have two terms for describing the ways in which these vehicles are used. They are "mechanization" and "motorization." Though they are often misinterpreted by the public as denoting the same thing, these terms actually have very different meanings.

A "mechanized" unit, in Army parlance, means one which is equipped with armed and armored vehicles, such as tanks and scout cars, with which the soldiers do their fighting. In addition it has enough trucks and cars so that every last man and pound of supplies is rolling on wheels when the unit is under way. A "motorized" unit, on the other hand, has enough trucks, cars, and other vehicles to transport all its men and equipment right up to the front lines, but there the men dismount and fight on foot while the vehicles retire to more protected areas. It does not have many armored vehicles which can go into action.

In the American Army, the term "armored" is used almost synonymously with "mechanized," so that the Armored Force is really a mechanized force. It also represents the part of the fighting team of the nation where the use of vehicles has been developed to its highest point. It is the

**MOTORIZED** units move men and equipment with motor vehicles, but fight on foot. Below, strength of a motorized division

OFFICERS AND MEN
16,129

STAFF CARS
10



MOTOR CYCLES
133



COMMAND CARS
365

MOTOR CYCLES (SIDE CAR)
107

PERSONNEL CARRIERS
603

MOTOR TRICYCLES
79

TRUCKS
1,074

SCOUT CARS
16

MISCELLANEOUS VEHICLES
315

### WEAPONS

*Rifles, .30 caliber, 7,842.*
*Machine guns, .30 caliber, 179.*
*Pistols, .45 caliber, 7,252.*
*Submachine guns, .45 caliber, 215.*
*Machine guns, .50 caliber, 113.*
*Guns, 37-mm., 60.*
*Mortars, 60-mm., 81.*
*Guns, 75-mm., 8.*
*Mortars, 81-mm., 36.*
*Howitzers, 105-mm., 36.*
*Howitzers, 155-mm., 12.*

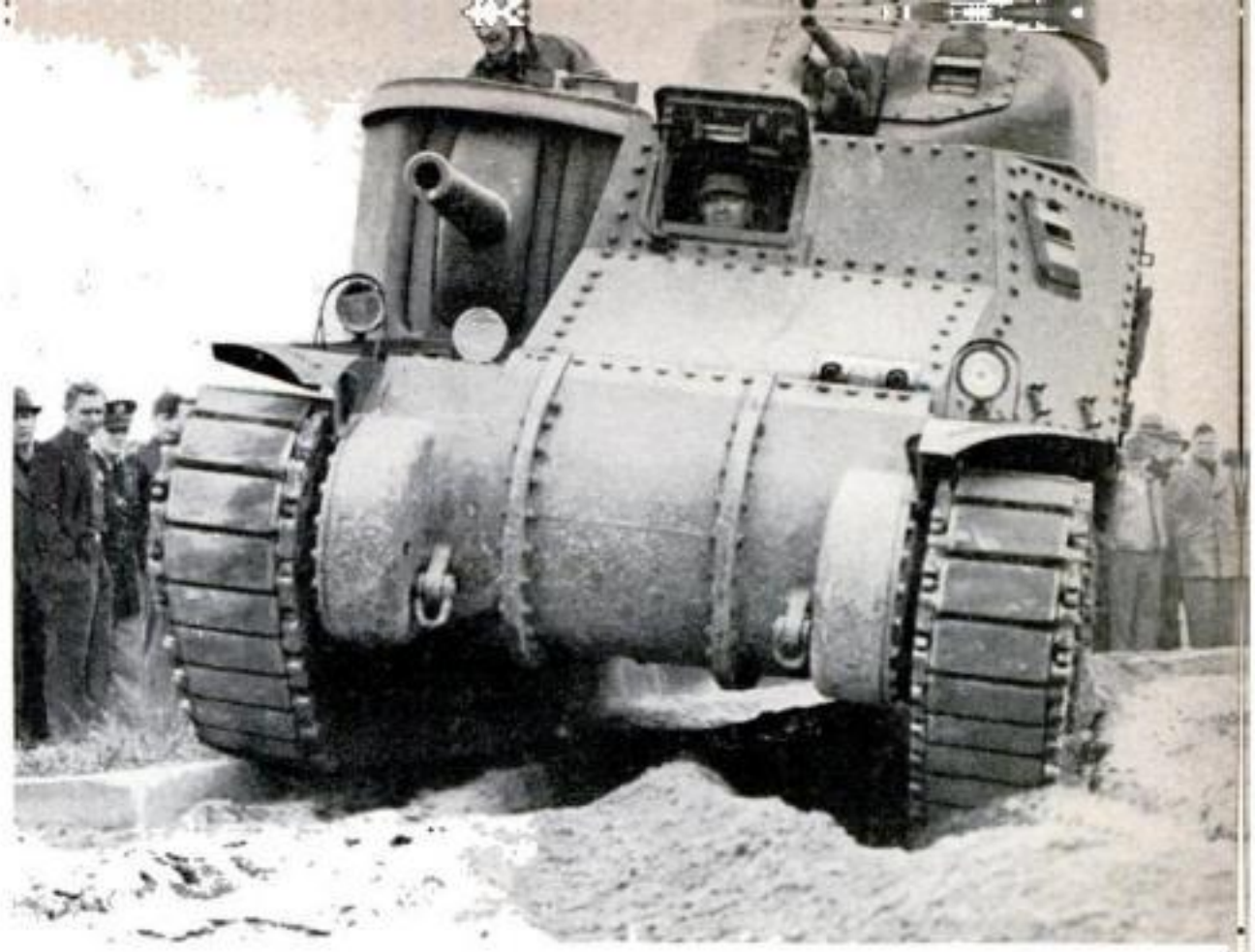
American equivalent of the "Panzer" and "blitzkrieg" forces of foreign armies.

Today it has four divisions organized, though a year ago it had none. Within a few months they will be fully manned and equipped, which means that each division will have 10,097 enlisted men, 600 officers, and more than 3,000 vehicles. A year from now, if nothing goes wrong, the Force will have been expanded to eight divisions.

Each of these divisions has six times the fire power and ten times the speed and distance-covering ability of an old-style muscle-propelled division. It can maintain a speed of 30 miles an hour on the highways and travel 150 miles in a day, or farther in forced marches. It goes into action ready to fire 700 tons of shells and bullets. It is so completely self-sufficient that it can cover between 300 and 500 miles without receiving any supplies other than what it carries in its trucks.

With a total weight of 8,500 tons of vehicles, it naturally takes a lot of fuel to move such a division very far. The tanks of the vehicles alone hold 123,000 gallons of gasoline and Diesel fuel, the equivalent of 15 railroad tank cars, and 70,000 gallons of that supply is burned up for every 100 miles the division travels. That means that to cover 300 miles, 90,000 gallons of fuel, in addition to that in the vehicle tanks, must be carted along with the outfit when it leaves its base.

Men must be fed as well as engines, even if a mechanized division does march on



Literally a rolling fortress is the U.S. Army's M-3 medium tank. Drags its 28 tons at a speed of 30 miles an hour on roads

**MECHANIZED** units use vehicles for fighting as well as traveling, and have more fire power. Below, a mechanized division

MEDIUM TANKS – 125
WEIGHT 28 TONS; CREW OF SIX; ONE 75-MM. GUN, ONE 37-MM. GUN, AND FOUR OR MORE MACHINE GUNS

## WEAPONS

*Rifles, .30 caliber, 2,230.*
*Machine guns, .30 caliber, 4,021.*
*Pistols, .45 caliber, 10,211.*
*Submachine guns, .45 caliber, 1,824.*
*Machine guns, .50 caliber, 852.*
*Guns, 37-mm., 473.*
*Mortars, 60-mm., 26.*
*Guns, 75-mm., 125.*
*Mortars, 81-mm., 18.*
*Howitzers, 105-mm., 36.*

OFFICERS AND MEN
10,697

COMMAND CARS
127

MOTOR CYCLES
534

ARMORED HALF-TRACKS
740

"BANTAM" CARS
290

TRUCKS
1,004

SCOUT CARS
110

MISCELLANEOUS VEHICLES
75

STAFF CARS
23

LIGHT TANKS
290

TRACKLESS TANK. A cross between a tank and an armored car is this experimental vehicle, shown undergoing tests by Armored Force technicians at Fort Knox, Ky. It weighs ten tons and is driven by a Diesel engine, making 80 miles an hour on roads, according to the builder. Cruising range without refueling is 500 to 600 miles. Drives through the six rear wheels, steers through the front two. For turning sharply, all the wheels on one side are braked

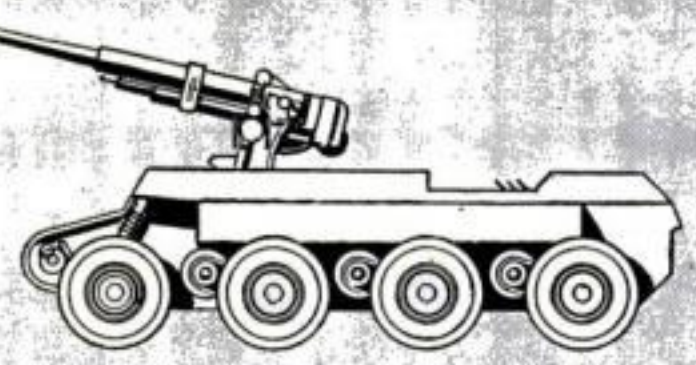
wheels. To accomplish this without interfering with unit's traveling ability, gasoline-burning ranges are mounted in rolling kitchens so that the cooks can start preparing a meal while the soldiers are still under way.

One important problem which the mechanized and motorized outfits share with the rest of the Army is the training of new men. In the case of the units that travel on wheels instead of their feet, however, the problem is a bit more complicated, as the recruits must be taught all the principles of soldiering that any trooper must know, and in addition must be taught to drive and maintain tanks, trucks, and other vehicles.

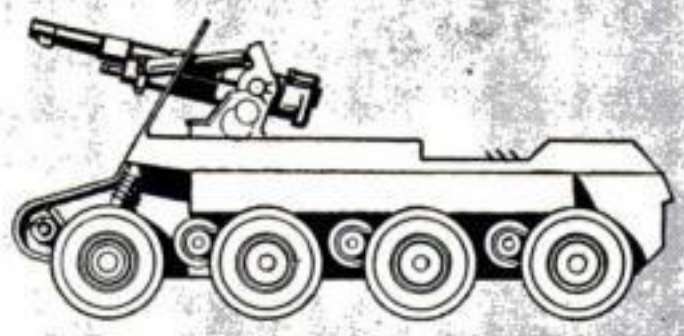
The speed with which the Armored Force recruits are being whipped into shape is a credit to its commander, Major Gen. Adna R. Chaffee, and the other officers who were planning the organization of the Force long before Congress provided the money to create it, and to Col. Stephen G. Henry. Colonel Henry, commandant of the Armored Force School, at Fort Knox, Ky., startled officers and men alike in the first World War by the speed with which he was able to train American doughboys in France. Now he is

## USES OF THE TRACKLESS TANK

With a heavy rapid-fire gun mounted in a turret, it could be a "tank destroyer"



As a mount for an antiaircraft gun, it would offer great mobility and speed



An assault gun could be carried right up to the front, fired while in motion

It takes 700 gallons of fuel to move a mechanized division a mile. Feeding 10,097 men and 3,000 vehicles is a big transportation problem

using the same technique to give Armored Force recruits their basic training with the greatest possible speed.

To eliminate misfits at the start, Col. Henry uses simple but effective tests. Soldiers to be trained as motor-cycle riders, for instance, must first prove that they can ride a bicycle. If they can't do that, no use wasting time on them. Soldiers who want to become Armored Force radio operators find themselves with a set of headphones clamped to their ears before they get any training at all. If they can recognize certain groups of signals in the dots and dashes with which they are bombarded, it's a good indication that they will be able to pick messages out of the ether even when bouncing along inside a roaring tank, with a 37-mm. or a 75-mm. gun banging away not far from their heads—and that's not easy.

Teaching of that type, however, is only a beginning. After they leave the school, the soldiers get more training in field work. According to Armored Force officers, it takes a full year to fit an Armored Force soldier into his niche in the fighting machine.

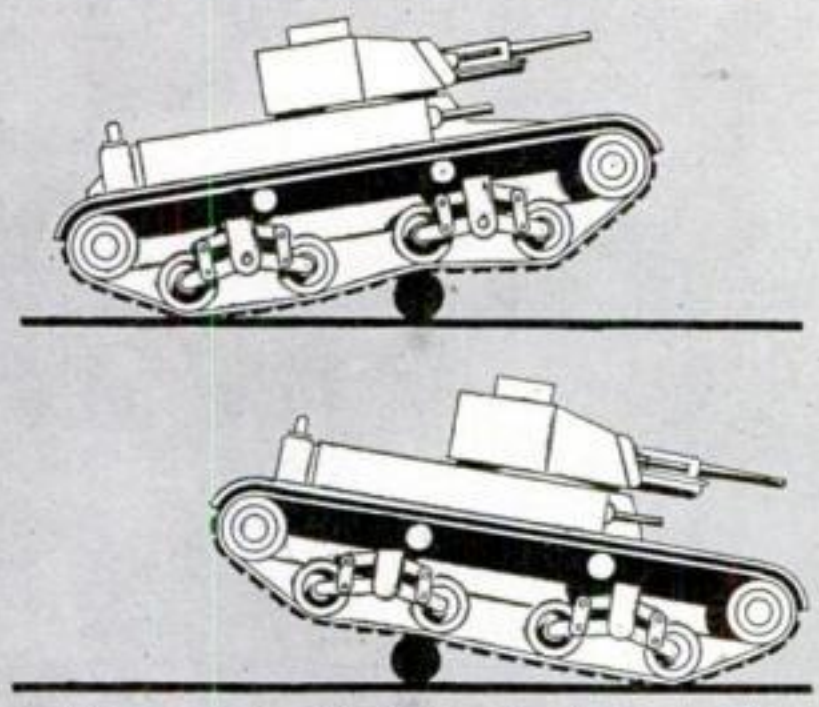
Officers and men alike must learn the importance of working together, and that can't be taught in a school. The biggest lesson that the American Army has learned from the present war in Europe is the importance of coöperation between the component parts of the Army team. Air Corps, artillery, infantry, Armored Force, cavalry, engineers—all must work together if the Army is to be effective.

The place of the Armored Force in the picture requires that soldiers of the Force must learn the technique of the "breakthrough"; punching a hole in the enemy line or swinging around his flank, and raising hob with his rear-area communication and supply lines. They must learn that their branch of the service has a tremendous striking power, but is weak in holding power. They must learn that if their vehicles try to operate where the terrain is against them, as in mountainous country or in marshes, they may be worse than useless.

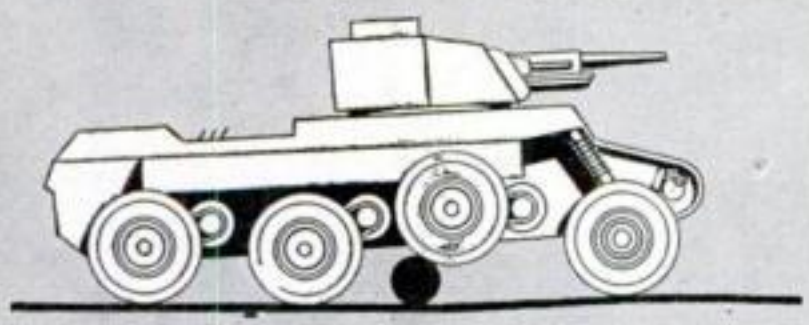
The biggest weapons in the ranks of a fully mechanized or armored, division, are the medium tanks. Unfortunately, the Army has comparatively few of these juggernauts because when the defense program got under way there were not enough factories with facilities to build them. Production was further held up by design changes made necessary by developments abroad.

When the Armored Force was organized

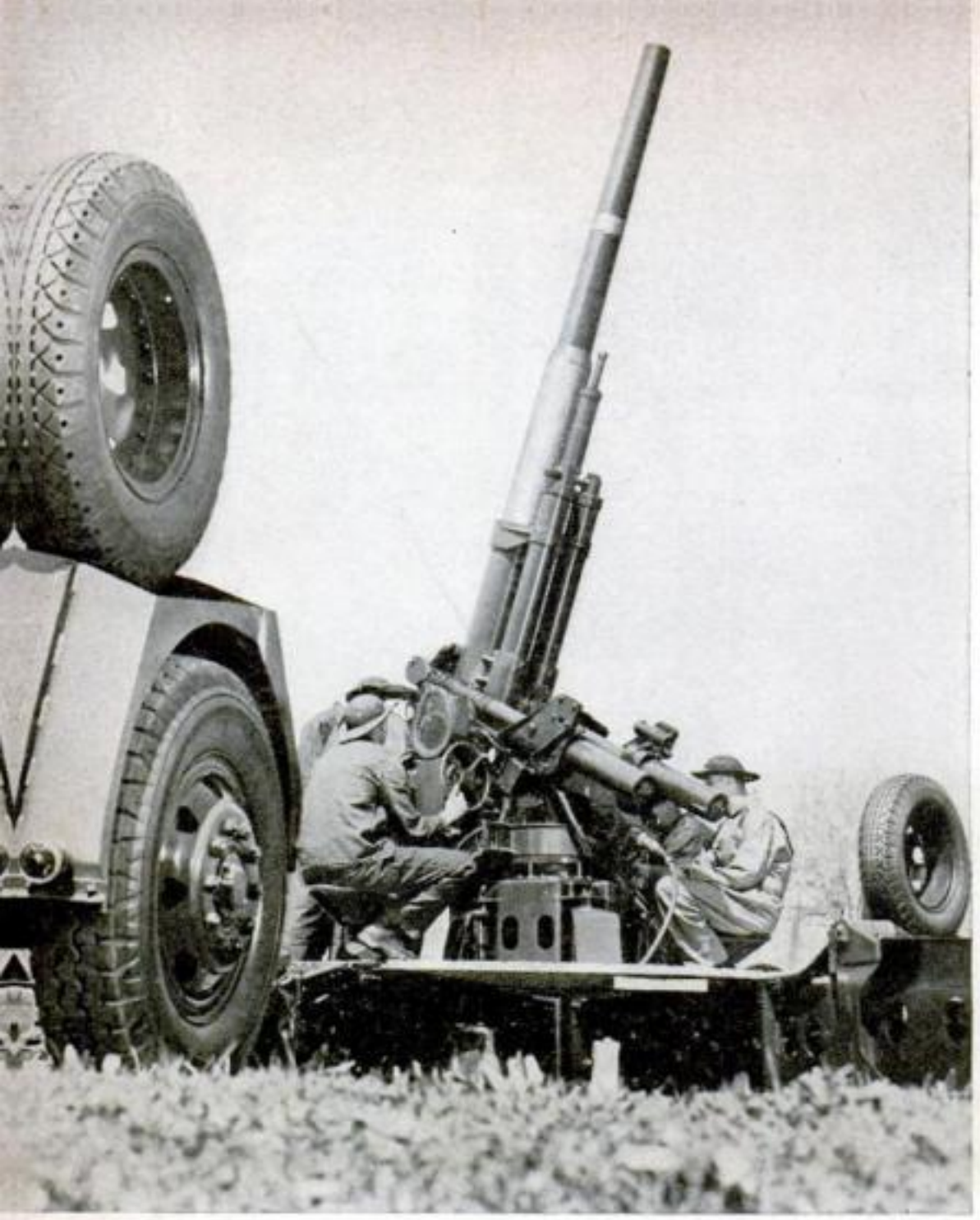
## MAKES A GOOD GUN PLATFORM

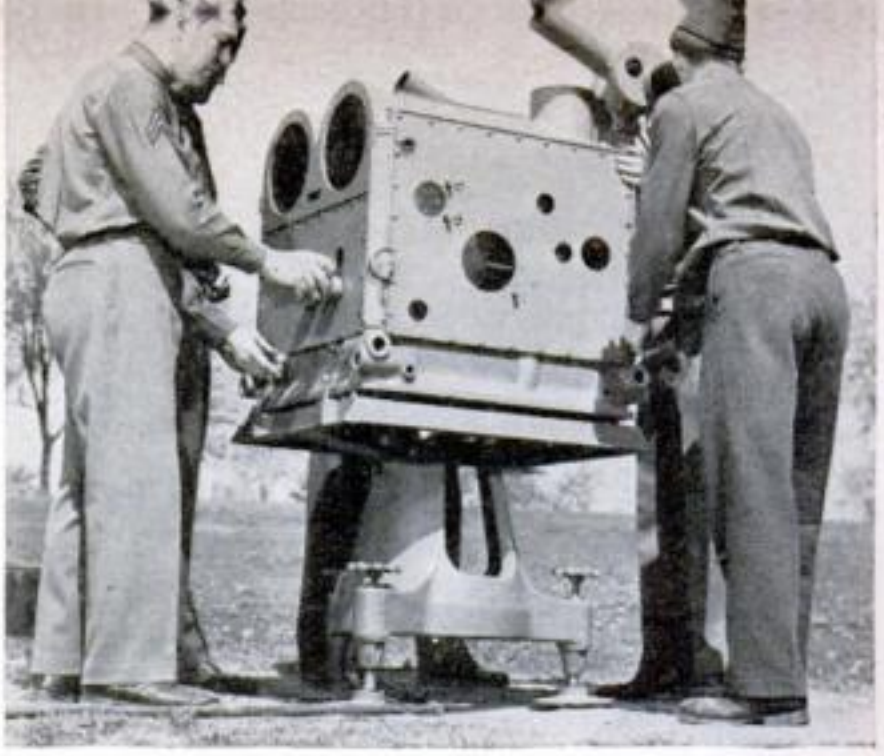


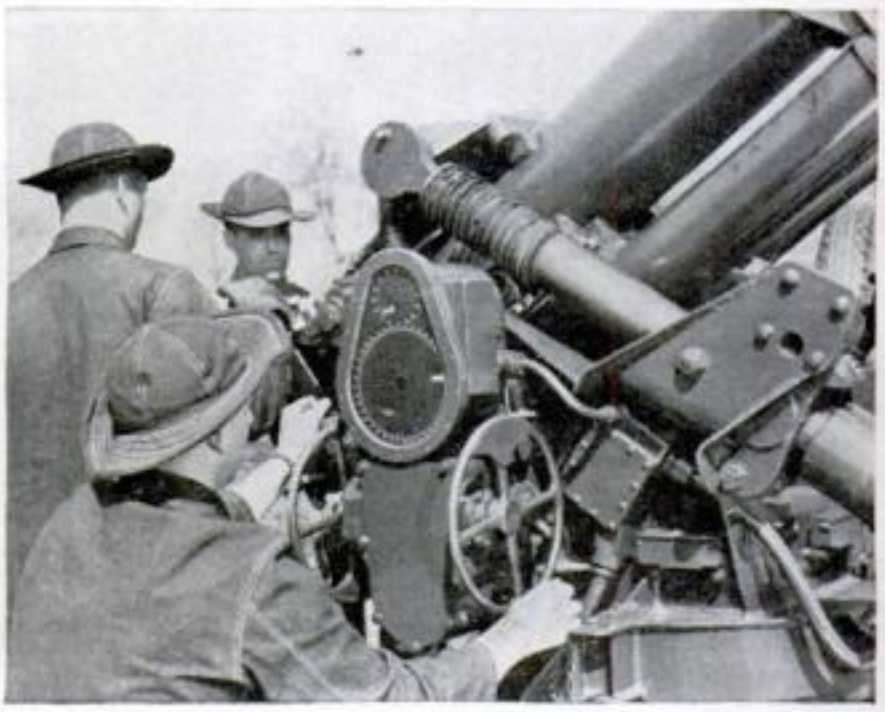
Whereas the track-type tank rears and dives in going over an obstacle, spoiling the aim of a gun fixed in a turret, . . .



. . . the trackless tank remains level as each wheel in turn rises over the hump







ANTIAIRCRAFT GUNS have to be able to cover the ground in a hurry. On the road, this three-inch-er rolls along at 40 miles an hour on a wheeled carriage that unfolds to form a firing base (1). The guns of a battery are drawn by seven-ton trucks and followed by trucks and trailers loaded with fire-control apparatus, generators, and ammunition

In action, a mechanical brain (2) takes readings from range finders and other instruments and combines them automatically to calculate firing data which are relayed to dials on the guns (3). There are two dials on each gun, one on either side. A gunner at each dial turns hand wheels until the position of the gun matches the firing data shown

MECHANICAL FINGERS in the fuse cutter set the shell's fuse to go off at just the right altitude. This device, mounted near the breech of the gun, is also operated by the mechanical brain. At the right, loaders are pushing a shell into the breech with the teamwork typical of all AA drill

a year ago, the only medium tanks the Army possessed were 18-ton jobs. Their heaviest weapon was a 37-mm. gun, and their armor plate was not thick enough to stop the shells of the antitank guns of foreign armies. But the brutes that will soon be rolling from the factories, known as M-3's, weigh 28 tons and carry a 75-mm. gun, backed up by a 37-mm. and four or more .30 caliber machine guns. They have much heavier armor than their predecessors, and travel 30 miles an hour on the highways and between 20 and 30 miles an hour cross country.

Next to these in order of size are the light tanks, which, in spite of their designation, weigh 12 tons. Now being produced five times as fast as they were at the beginning of 1941, these tanks are a good example of how mechanization has increased the speed and fire power of the soldiers. A single light tank has the fire power of 40 infantrymen. It mounts a 37-mm. gun which fires a two-pound high-explosive or armor-piercing shell, and four .30 caliber machine guns. The latter can be taken out of their mounts and used on the ground if the tank becomes disabled. And the tank can do 45 miles an hour on the highways, 30 or better across-country.

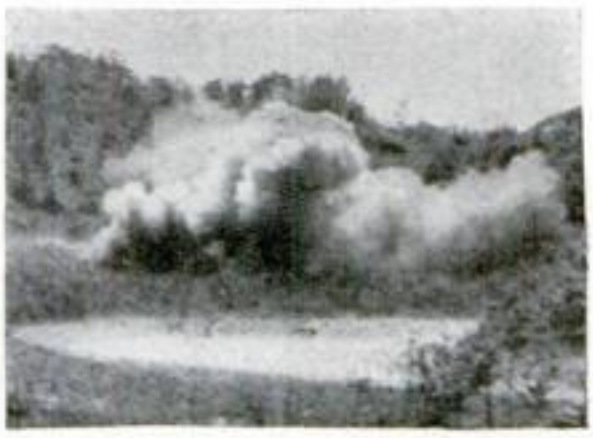
Both the medium and the light tanks now being produced incorporate all the improvements that the designers could work in. Some of the items included in these latest types not found in earlier models are power-operated turrets, electrically controlled guns, indirect and periscopic sights, and improved cold-weather starting.

Though the Army has tanks that it considers the equals of any built abroad, it hasn't stopped experimenting. Recently it started tests on an eight-wheeled, trackless vehicle which has been called both a tank and a pursuit car. According to the manufacturer this 10-ton, Diesel-propelled buggy can travel 80 miles an hour on the highways and cover 500 or 600 miles without refueling. Because of low center of gravity and airplane-type wheel-suspension system it is supposed to provide a much steadier gun platform than the conventional type of tank. Some experts in the field of mechanization believe that the answer to the tank menace is a tank "destroyer," the sole purpose of which would be to attack and destroy enemy tanks. Such a vehicle as the trackless tank, fitted with a single 75-mm. gun, might prove ideal for this type of fighting. The manufacturer also states that it could be used effectively as a mobile gun carrier for heavy weapons such as antiaircraft guns, or assault guns.

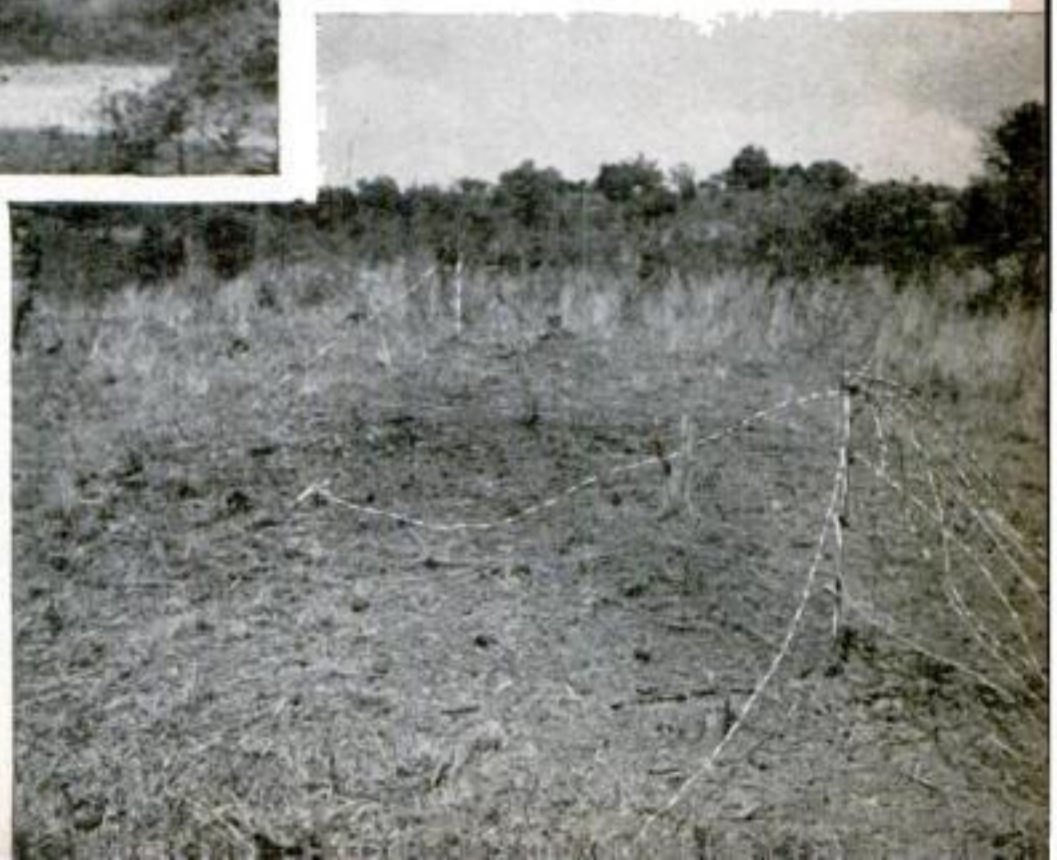
While the tanks are the heavyweights of the Armored Force, they are numerically a small part of the vehicles it uses. An armored division has only 290 light and 125 medium tanks, while there are 792 2½-ton trucks, 534 motor cycles, and 290 "bantams," plus scout cars and other vehicles, in the same division.

The "bantams," also known to the soldiers as "beetle-bugs," "jeeps," and by several other names, are stocky little vehicles only recently adopted for Army use. Weighing 2,700 pounds fully loaded, they are proving to be effective chore boys in the Armored Force as well as in other branches of the service. Powered with 45-horsepower, four-cylinder, gasoline engines and equipped with a four-wheel drive, they carry three men and a machine gun at 60 miles an hour on the roads. Their short wheelbase makes them readily maneuverable at close quarters, and in cross-country work they can do everything but climb trees. If they get bogged in a mudhole, the crews can usually horse them back to solid ground and carry on under their own power. These vehicles have also

To blast a path through enemy wire, a Bangalore torpedo—a length of pipe filled with explosive, is shoved under it . . .

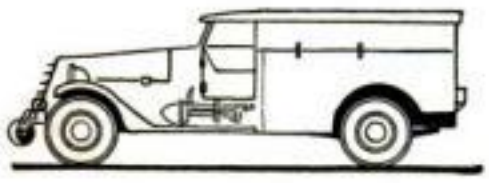


. . . and set off by an electric spark or a fuse. In the photograph below, a 30-pound charge has smashed the wire

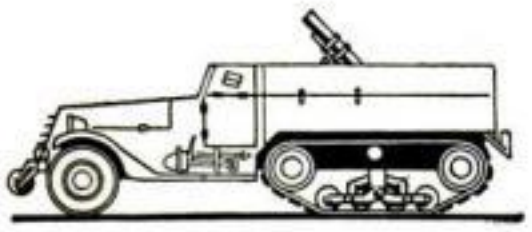


## STANDARDIZATION MAKES MAINTENANCE EASIER

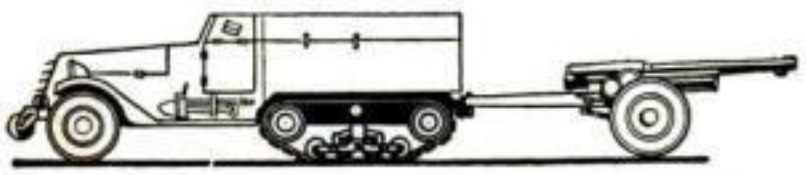
Similar, except longer, is the personnel carrier. Takes 14 men



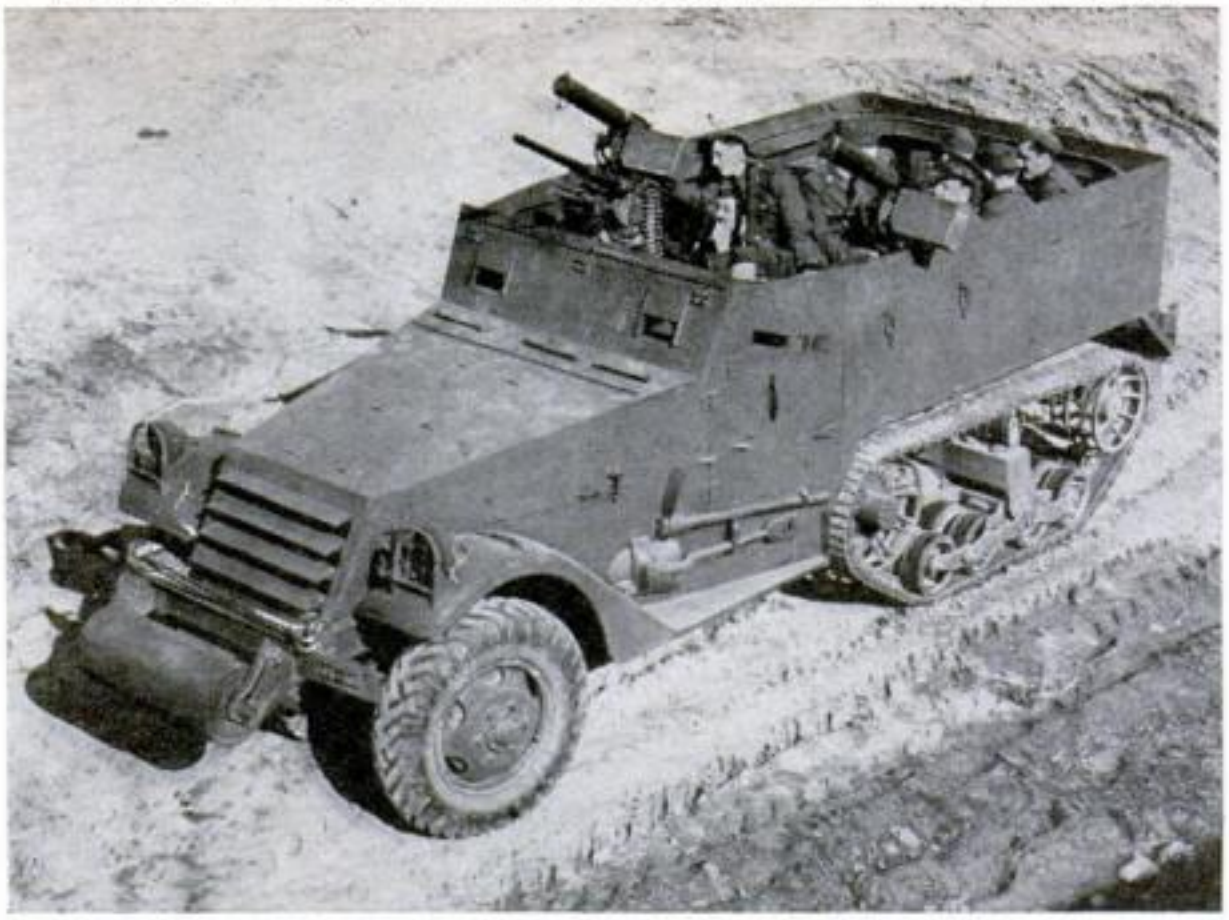
The scout car runs on wheels. Hits a mile a minute on roads



Half-track carrying a mortar. Gun fired aboard or dismounted



Half-track used as a "prime mover," for hauling a gun



Mounted on half-tracks, the car-personnel can carry eight men

proved effective for towing 37-mm. antitank guns on two-wheeled carriages.

To simplify the task of maintaining its multiplicity of vehicles, the Armored Force has gone in for standardization in a big way. When the force was organized, about 35 different types of cars, trucks, and other wheeled equipment were found among the units of artillery, infantry, cavalry, engineers, and other branches of the service which were pieced together to form the force.

Now that has been cut to eight principal types, with a few miscellaneous units such as wreckers and shop trucks. This means that when an armored division takes the road, it will have to carry repair parts for only eight instead of 35 types of vehicles.

In addition to the eight mechanized or armored divisions which will be using all this equipment, the Army already has one motorized infantry division, and is planning to motorize four more within the next year. If the factories keep on turning out the guns, tanks, and trucks, the Army has no doubt that it can build just as good a fighting machine as any it may run up against.

MAINTENANCE is simplified for the Armored Force by limiting the vehicles to eight principal types. The five cars shown above make up one such group, in which the repair parts are interchangeable. This also makes it easier to train mechanics for field shops, below

# The Little Factory Joins Up

By EDWIN TEALE

Little factories in loft buildings, on side streets, in small towns—plants that make a thousand and one varied products—form the infantry of America's army of defense-production. Individually small, they are collectively indispensable. Switching from a wide range of peacetime products, thousands of small industries in all parts of the country have turned to the manufacture of odd but essential items of defense.

In one Eastern city, a rat-trap factory is making springs for army cots. A manufacturer of novelty ash trays is stamping out accessories for fighting planes. The Queens Machine Corp. of Brooklyn, N. Y., a knitting-machinery concern, is producing torpedo parts and a steel-cabinet plant, the Ferro-Co Corp. of the same city, is making seaplane floats. In New England, a pipe-organ maker has switched to the manufacture of saddle trees. And, a shop with duck decoys as its regular product, is now making shoe lasts to army specifications.

Early this spring, bird-cage manufacturers in several parts of the country shifted over to the production of fuses for artillery shells. In New York City's garment center, a shop which previously made veils for women's hats is now turning out mosquito netting for army and navy use. Near by, plants which have bedspreads, draperies, and women's lingerie as their usual products, are transforming the netting into mosquito-proof covers for army cots. Gold insignia for army uniforms are being turned out in mass production by the Rex Products Corp., of New Rochelle, N. Y. Its usual stock in trade is compacts for women.

From shower-bath heads to cartridge shells and from model trains to ship compasses are two other transitions in manufacture brought about by industrial mobilization for defense. In Los Angeles, Calif., the Metlox Corp., a pottery shop which ordinarily makes vases and statuettes of deer, is now working top speed on airplane parts; in Waterbury, Conn., a button concern is producing parts for field kitchens; and in Boston, Mass., a small shop owned by William Bailie, which usually is devoted to the making of bassinets for babies, has become the center of production for rattan bumpers that are used on cruisers, destroyers, and


Verne Dale, owner of Outer's Laboratory at Onalaska, Wis., has 30 employees making ramrods for the Savage Arms Co., Springfield Arsenal, and FBI

The Bailie Basket Works, Boston, has turned from making bassinets to rattan bumpers for ships

Auxiliary craft use balls of this size, which can be made in a day. The biggest take two weeks

submarines of the Navy.

For almost half a century, this little wickerwork shop has operated in the same dusty, second-story room close to the Boston waterfront. Its eight skilled workmen all came from the same community in Poland. With rattan imported from the Malay Peninsula, they produce three sizes of bumpers. The largest, a six-foot cylinder approximately three feet in diameter and weighing close to 200 pounds, requires two weeks to complete. The smallest, an eighteen-inch ball of woven rattan, can be finished in one day. Because of its light weight, resiliency, and resistance to sea water, rattan provides the most satisfactory bumpers for naval craft.

Another unusual small industry which is doing a big job for defense is located at Onalaska, Wis. Several years ago, Verne Dale started a little plant in this community of 1,400 inhabitants for making cleaning rods and gun gadgets for sportsmen. As no firearm, whether a Garand rifle or a sixteen-inch naval gun, will be worth much for long unless it is kept properly cleaned, firearm cleaning equipment has become a vitally important defense item. In consequence, Dale's business has zoomed during the past year. He now has thirty workmen in his Onalaska plant and eight more in a second shop erected on a farm two miles from town. His present orders from the Springfield Armory and from private companies making small arms for the Government, call for 200,000 cleaning rods a year.

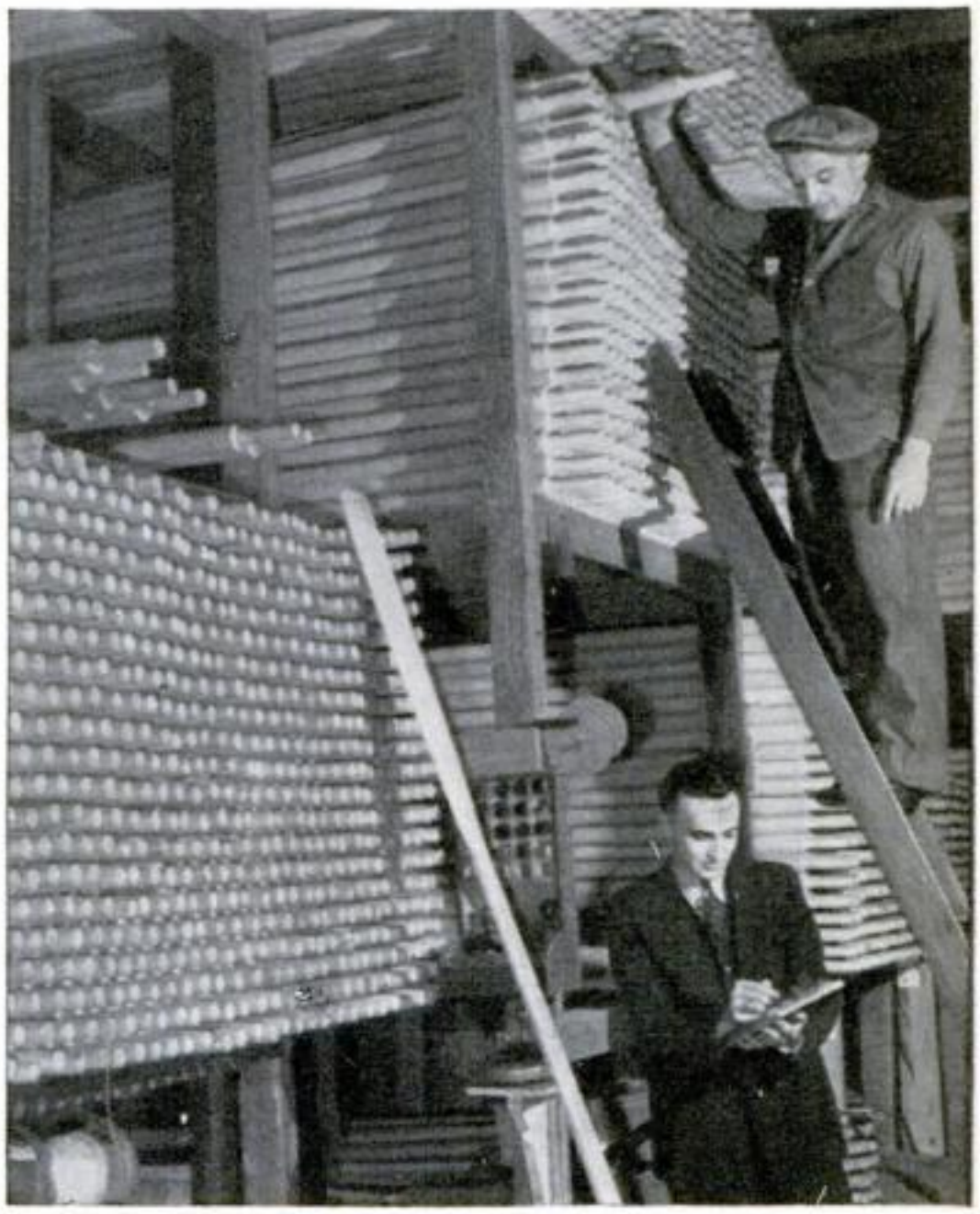
When the defense drive started a year ago, Army and Navy officials, anxious to get standard products as quickly as possible, naturally placed most of their orders with big manufacturers. Although 13,000 companies, large and small, received

contracts, $9,000,000,000 worth of orders went to about 600 big companies while the remaining $1,000,000,000 in business was divided between more than 12,000 smaller concerns. As a result, the large factories were jammed with orders while many of the smaller concerns, which really needed business, were left idle or working only part time on their normal output.

Since then, the Government has taken special steps to remedy the situation. Of the 50,000 companies in America originally considered "usable" by the War Department —large and small established concerns of good reputation and with ten or more employees — 15,000 have now received prime contracts, 30,000 have sub-contracts, and only 5,000 have not as yet engaged in defense work.

In Brooklyn, N. Y., the Sperry Gyroscope Company, with something like $100,000,000 worth of defense contracts tucked away in the safe, is now obtaining parts for its gyro compasses, automatic pilots, antiaircraft equipment, and searchlights from more than forty smaller factories. A special division has been set up by the Sperry company to handle and supervise these sub-contracts. Other concerns holding major contracts with the Government have similarly "farmed out" part of their work. In Milwaukee, Wis., the big Kearney and Trecker machine plant has let sub-contracts to nearly 100 smaller concerns. The American Car and Foundry Company, making the latest-type light tanks for the Army, has 117 other plants helping turn out the 10,000-odd parts that go into one of these fighting machines. In some instances, these sub-contractors have even let sub-sub-contracts.

In the long-range view, as well as in the



Workmen at the New York Boat Company check over part of the Government's order for $15,000 worth of oars for small boats

Shulman and Goldberg, of New York City, now make mosquito bars as well as the draperies and spreads they ordinarily produce


Two blocks from the roller coaster at Coney Island this plating works, run by Miss Ann Kavun, 23, a beauty-prize winner, fills defense orders

G. Ruspantini, the owner, and his workmen at the Coney Island plant, keep busy on a bewildering variety of subcontracts for the Government

light of present necessity, the use of small factories now in existence rather than the building of huge new defense plants, has special importance. At a future day, when American industry returns to peacetime production, little factories that are scattered throughout the country can turn to the making of innumerable and varied items. They will provide a cushion against the jar of sudden economic change.

Up until last year, a Federal contract could not be assigned as collateral to a bank, as could state or local contracts. When the defense drive began, this situation was found to work a hardship on the small industry. To expand and buy materials, it needed loans. So Congress passed a new law known as the Assignment of Claims Act of 1940, to enable a manufacturer to take his defense contract to the local bank and use it as security for a loan.

Another step in simplifying procedure has been supplying workmen with models as well as blueprints. In many small plants, mechanics can reproduce anything they can examine and take apart. But they are hazy on blueprints. In the early days of the defense drive, a manufacturer of street cleaning equipment in New Orleans, La., bid on a contract for supplying toothbrushes to the Army. Being unfamiliar with Government specifications, he misread some of the figures and turned out a sample toothbrush six feet long!

The most important step of all in aiding the little fellow in defense work has been the establishment of the Defense Contract Service as part of the Office of Production

Management, in Washington, D. C. In co-operation with Federal Reserve banks or branch banks, this service has offices in about 40 cities. Each office is equipped with a staff of experts to give engineering, financial, and contract-procedure advice to small companies. Further aid to the sub-contracting, or "bits and pieces," program of the Government is being provided by more than 100 local defense-production groups, by state defense councils and by manufacturers associations. In Brooklyn, N. Y., the local Chamber of Commerce mailed out questionnaires to more than 2,000 different companies.

Returns from such questionnaires have been a great help in finding what the different small companies are best equipped to make. One survey revealed that manufacturers of garden rakes could produce bayonets; that makers of house slippers could turn out aviators' boots; that furniture plants were anxious to make gunstocks; that a fashion-accessory concern could produce cartridge belts; that a textile trimming plant was all set to make gun swabs; and that a maker of fireplace pokers could just as well produce U-bolts for the Navy.

In Cleveland, an investigation revealed that, unknown to a majority of local businessmen, there were 140 small shops in the area equipped with machinery that made them valuable in the defense set-up. In one instance, a plant employing seventeen good power tools was discovered operating in a barn. Today, small shops in the Cleveland area are turning out fuses, primers, boosters, and binoculars, as well as parts for trucks, planes, and ponton bridges. York, Pa., is another community which has made a careful survey of its small-factory assets. Fourteen hundred machine tools in 180 small shops outside the main plants of the city were brought to light by the York Defense Program Committee. Equipment owned by makers of cement, biscuits, false teeth, roofing material, and hosiery was found adaptable to defense production needs. One of the finest machine shops in the city was discovered in a caramel factory where mechanics make their own power tools.

Tying screws to copper wire before placing them in the acid bath for electroplating. A simple turn of the wrist and each is fastened securely

In a number of instances, old machine tools considered inefficient by 1941 standards have been brought into defense service by minor repairs or by using them for work far different from that for which they were designed. In Vermont, for example, machines originally used for cutting stone have been adapted for the rough-cutting of metal. Another example of the use of old-style facilities to meet the extraordinary needs of the present program is the reappearance of beehive coke ovens in Pennsylvania, West Virginia, Maryland, Alabama, and Colorado.

These old-timers were virtually abandoned following the advent of the modern steel-mill oven. They lose or burn up gas, ammonia, tar and by-products used in dyes and explosives, which the newer ovens retain. But in the present emergency, they provide a quick method for producing the coke badly needed by the steel industry.

During the twelve months that have just passed, the defense program has brought to American industry the most rapid expansion of plant capacity in its history. Seven hundred and eighty-four new factories have gone up at a cost of more than $2,000,000,000. Including orders placed by the British Government before the passage of the lease-lend bill—but excluding our emergency shipbuilding program—defense expenditures and authorizations have reached a total of more than $44,000,000,000.

Yet, management engineers estimate that one-half of our machine tools are idle or are working less than eight hours a day, and that we are producing no more than thirty or forty percent of the defense material that our total facilities are capable of turning out. Fifty percent of all the machine tools in America — excluding special-purpose equipment—are located in shops that employ fewer than 100 workmen. The small industries of the country still form the great reserve of production possibilities. Efficient use of these possibilities promises the shortest road to the goal of total defense.

# NAVY'S TRIPLE THREAT

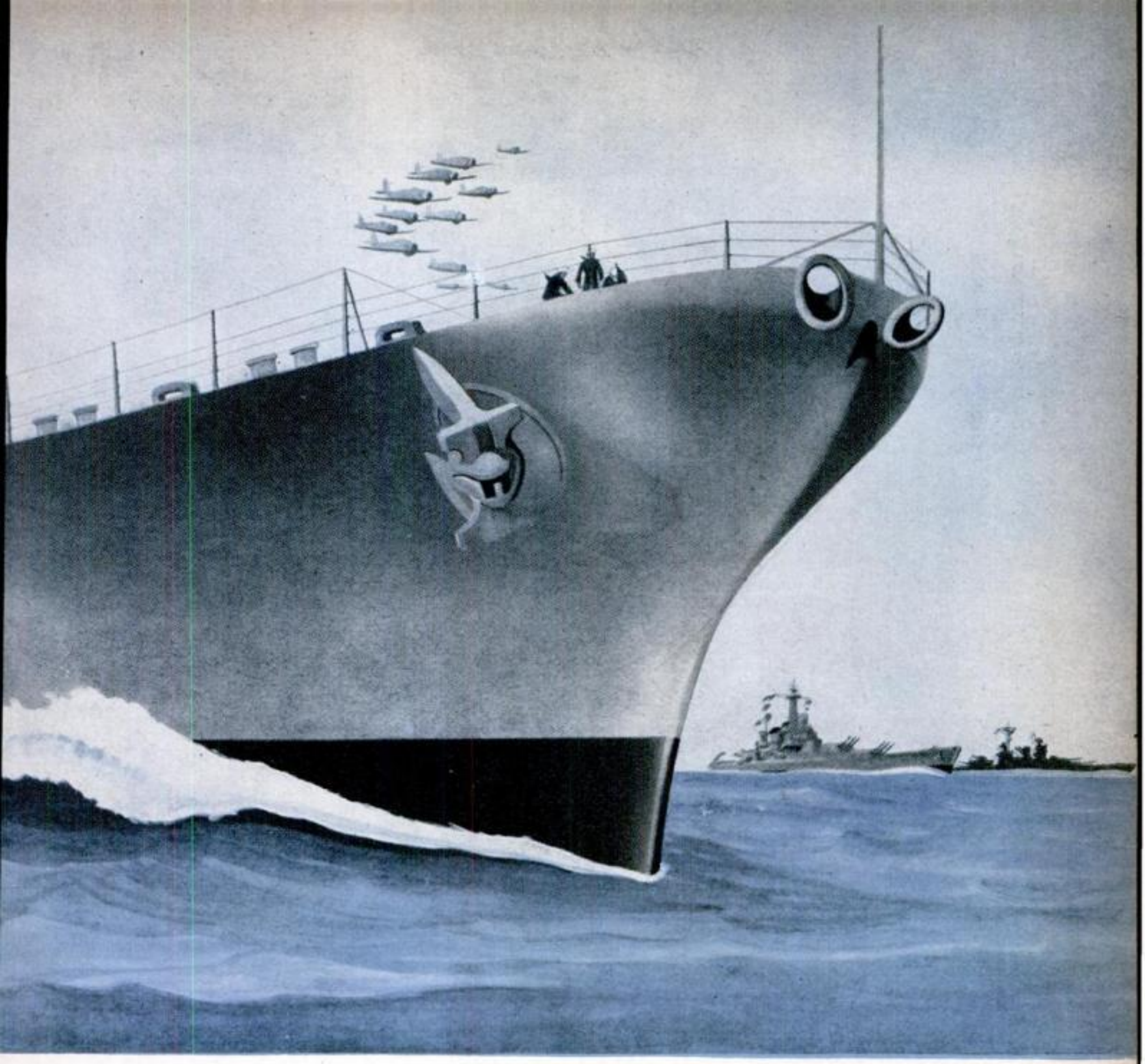
## —Fire Power, Speed, and Armor

By ALDEN P. ARMAGNAC

*Paintings by Matt Murphey, U.S.N.*

REINFORCING the United States Navy at a time when they are extremely welcome, the two most formidable battleships in the world have just been placed in commission. Sister ships of 35,000 tons each, the mighty *North Carolina* and *Washington* excel anything else afloat in their combination of guns, speed, and armor —the three vital elements of a ship of the line.

Nine 16-inch rifles belch a ten-ton broadside of steel and T.N.T. to a distance of 20 miles. A "designed" or rated speed of 27 knots keeps up with today's demand for faster and faster ships—and battleships, like race horses, have a way of being conservatively rated by their owners before



U.S.S. "North Carolina" and her sister ship "Washington," are Navy's newest battleships. They carry 9 16-inch and 20 5-inch guns, have underwater protection against torpedoes. Speed rating is 27 knots

they go into action. Either of the new ships could be struck by as many as five torpedoes and keep right on fighting, it has been estimated, because of their antitorpedo bulges and extreme subdivision into watertight compartments. "Belt" or side armor reportedly 16 inches thick protects magazines and machinery from shellfire, and ten inches of deck armor resists the heaviest bombs from the air.

Manned by 1,500 officers and men, each 750-foot floating fortress mounts three huge turrets, of which the rotating part weighs 1,500 tons, or about as much as a modern destroyer. Secondary and antiaircraft guns embody latest designs—of which more later. Three to four planes, launched from catapults, spot artillery fire. Geared turbines that drive quadruple screws consume enough power for Jersey City, N. J., or Houston, Tex. A new steering system, with twin rudders, is reported. Preparation of thousands of working drawings for the ships took two years in itself, and the result is called the finest of 140 different kinds of battleships. Owing to a changed method of figuring tonnage, the *Washington* and *North Carolina* exceed the size of their "43,200-ton" namesakes which were scrapped when partially completed, in postwar disarmament.

In hundreds of items, from sailors' uniforms to superdreadnoughts, the Navy has been modernizing itself for today's style of warfare. Sidelights as diversified as these

might be picked at random from a bulletin board of recent naval news:

Sailors on shore leave no longer will advertise the whereabouts of any particular warship by its name on their cap ribbons. The words "U. S. Navy" are now being substituted.

Because white uniforms have been found too conspicuous aboard ship, the "camouflage" of khaki-colored working uniforms has been adopted.

Records fall as construction leaps a year ahead of schedule for battleships and nearly as much for cruisers.

Veterans of Mississippi River traffic soon will blink their eyes at the sight of U. S. submarines, built at a Wisconsin shipyard and traveling down Ol' Man River to the Gulf.

Lieutenant Commander J. J. Tunney, none other than the Gene Tunney of heavyweight boxing fame, takes charge of physical training for Navy men, and officers keep fit with an exercising machine of his invention.

Vessels of the Atlantic Fleet get a new war paint of darker gray.

Crews of "mosquito" patrol torpedo boats devise hand signals for maneuvers at 72 miles an hour, a pace that outrules the traditional signal flags.

Latest of the Navy's long-range patrol bombers mount three power-driven gun turrets, a system inspired by war experience abroad.

Dozens of private yachts, sold or presented to the Navy, join the sea forces as gunboats, sub chasers, and patrol boats. A car ferry becomes a mine layer.

Plans advance for converting cargo ships into miniature aircraft carriers.

Radio-controlled planes simulate dive bombers for Navy target practice—and are brought down with gratifying frequency.

New and secret inventions detect submarines, warn of approaching ships and aircraft, and aid in high-speed mine sweeping.

Variable-pitch propellers for warships are being developed. Like airplane propellers, they automatically change their "bite" in accordance with load, assuring maximum efficiency at all times.

Here is some bigger news: According to Rear Admiral S. M. Robinson, chief of the Navy's new Bureau of Ships, three outstanding developments—protection against magnetic mines, more and better guns, and antiaircraft measures—have transformed what naval men now call the "old" fleet of July, 1940.

Working swiftly and quietly, naval experts had 319 U. S. warships and auxiliaries fitted to neutralize magnetic mines by as early as February of this year, and work on 115 more vessels was under way. The system encircles a ship with a band of wires carrying electric current, which counteracts the magnetic effect of the metal hull and keeps the mines from exploding. A curious phenomenon is that magnetic compasses go awry when the device is turned on, but this does not matter to modern ships equipped with gyro compasses, which are unaffected.

First installations of the antimagnetic "degaussing girdle"—named after the gauss, a magnetic unit—were temporary. Early this year, the Navy perfected a permanent de-gaussing system, costing an average of $20,000 per vessel, that will be good for the life of the ship. Replacements will be made as vessels come in for overhaul, but already the Navy feels satisfied that it has conquered the magnetic-mine menace.

Guns for warships, guns for some 115 naval auxiliaries that go unarmed in "normal peacetime," still more guns for vessels taken over from commercial service —these have been another key part in putting the fleet on a war footing.

Pride of the Navy is its new five-inch gun for destroyers and, as secondary armament, for cruisers and battleships. This double-purpose weapon can be trained on sea targets, or elevated to extreme angles for antiaircraft fire. Turrets mount the guns in pairs. They supersede a shorter-barreled five-inch gun, which in turn replaced a three-incher. Remarkable range and rapidity of fire distinguish the newest guns. Besides installations on battleships, they have been placed on the latest cruisers and on all destroyers. They may clearly be seen in the painting of the *North Carolina* on pages 86 and 87, installed at two levels along the side of the ship.

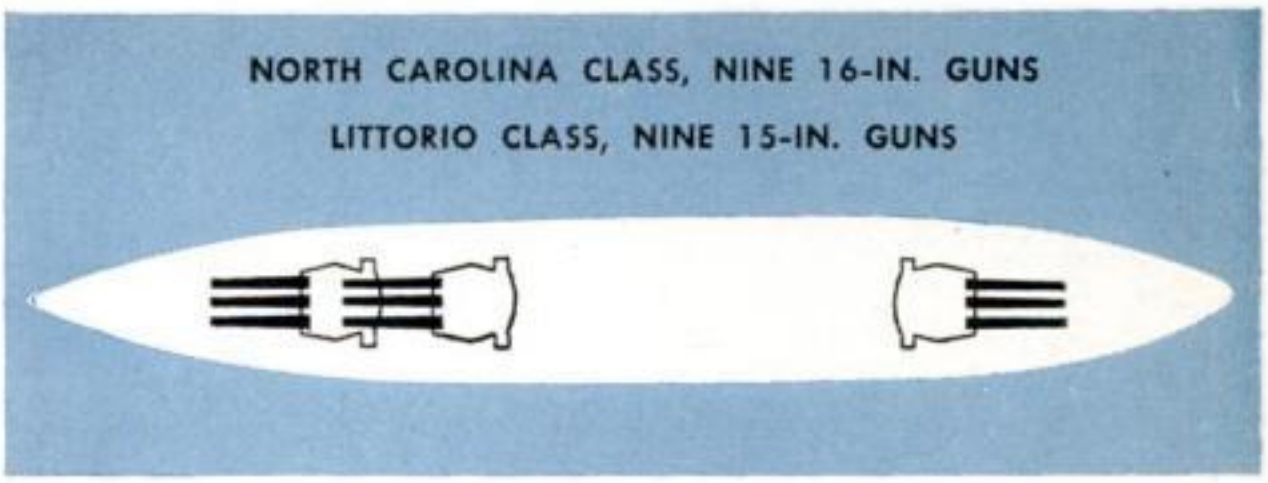
For defense against dive bombers, the U. S. Navy has developed a new 1.1-inch, multiple-barreled pom-pom gun or "machine cannon," according to Rear Admiral W. R. Furlong, chief of the Navy's Bureau of Ordnance. A burst of its ultra-rapid fire fills the air with explosive one-pound shells, capable of winging or completely demolishing a plane with a single hit. Four to eight of these deadly batteries, placed at strategic posts on the topside, go into action under centralized director control. First deliveries have been slower than the Navy would like, but it expects to get at least 400 of the guns this year.

"Splinter protection," the third main advance, shields formerly exposed members of the crew from fragments of bombs, and from pieces of steel that a bomb may knock off. The war has shown this flying debris far more dangerous to personnel than had been expected. Therefore, as much topside armor as can be installed, without impair-

# NAVY FIRE POWER: A MIGHTY LANGUAGE

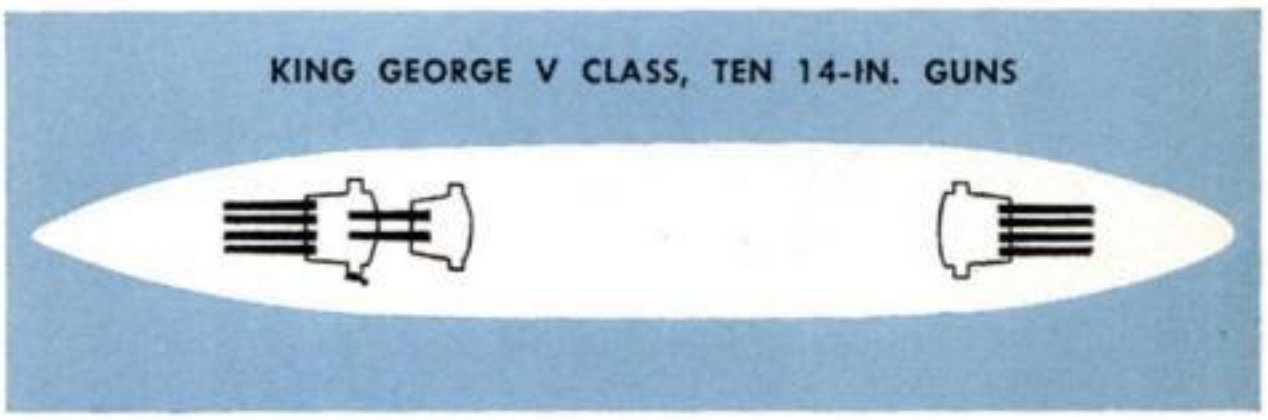
## UNITED STATES, ITALY:

New-battleship guns of these nations speak from three turrets, two forward and one aft. Concentration of triple-gun turrets forward is advantage, and turret aft can strike back at pursuers if speed of vessel is retarded by battle damage, or turn to bolster broadsides



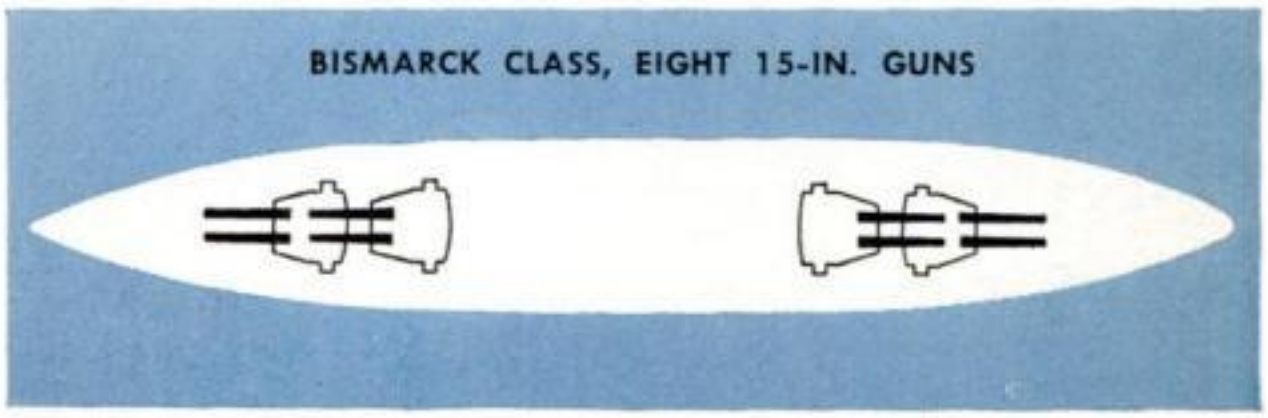

## GREAT BRITAIN:

Another well-balanced arrangement of guns in a fast ship of the line. Note the quadruple guns for firing either ahead or astern. While one turret has only two guns, the forward gun total is equal to that of the three-gun turrets of the class shown above




## GERMANY:

Named after the ship that sank the 42,100-ton British battle cruiser "Hood," this class is outranked only by the battleships above. Like Japan's older battleships of the "Nagato" class, these carry equal fire power for salvos either ahead or astern, and use twin turrets




ing the stability of the ship, has been adopted to protect U. S. gun crews, observers, and signalmen. As this is written, most of our 58 large warships, including all battleships, have been fitted with splinter protection.

New ideas in power plants occupy a prominent place among other modern naval developments. Operating under 600 to 800 pounds of steam pressure, compared with the 150-pound pressure of most ships in the last war, the *North Carolina* and *Washington* are our first battleships employing the high-temperature, high-pressure systems already tried out successfully in smaller U. S. warcraft. Diesel engines for major warships, introduced in the German pocket battleships, are rated as a development worth watching. And within a few months, the Navy is scheduled to receive a gas turbine, which, according to Admiral Robinson, "is revolutionary in design and promises a new era in power for propulsion of ships." It will be subjected to extensive trials, first in the Engineering Experiment Station at Annapolis and then in a ship. As many readers of this magazine will recall, a gas turbine works much like a steam turbine, but the steam is replaced by a searing blast of vapor from ignited fuel. Practical dry-land power plants using gas turbines have been developed only within the last few years (P.S.M., Dec. '39, p. 80), and use of a gas turbine to propel a warship would be an innovation of the first magnitude.

What the Navy calls a "projectile program" has been carried on for three or four years. Improved naval shells have been produced by special heat treatment, which prevents the missiles from breaking up when they meet their mark. As Admiral Furlong puts it, "It gives you the ability to pierce a given thickness of armor plate at a much greater range." Providing battleships with 16-inch and 14-inch armor-piercing shells of the new type has come first in the program, which also includes eight-inch shells for the guns of heavy cruisers.

"A recent experiment where one of our battleships actually fired on another one," Admiral Furlong says, "clearly showed that improvements could be made in the con-

struction of gun turrets." Not officially identified in this startling statement, the target ship may have been the radio-controlled *Utah,* capable of operating without a crew aboard. The Navy is taking advantage of the test's results on each battleship and cruiser in service. What they were remains its secret.

Among the most novel of fighting ships under construction and on order for the Navy will be our first battle cruisers—the recently contracted-for *Alaska. Samoa, Hawaii, Philippines, Puerto Rico,* and *Guam.* From their cost of $53,400,000 apiece for hull and machinery alone, the only detail made public, naval experts guess them to be ships of between 25,000 and 27,500 tons, mounting 12-inch or 14-inch guns. If so, they will be comparable to the German ships *Scharnhorst* and *Gneisenau,* which have been used as fast sea raiders.

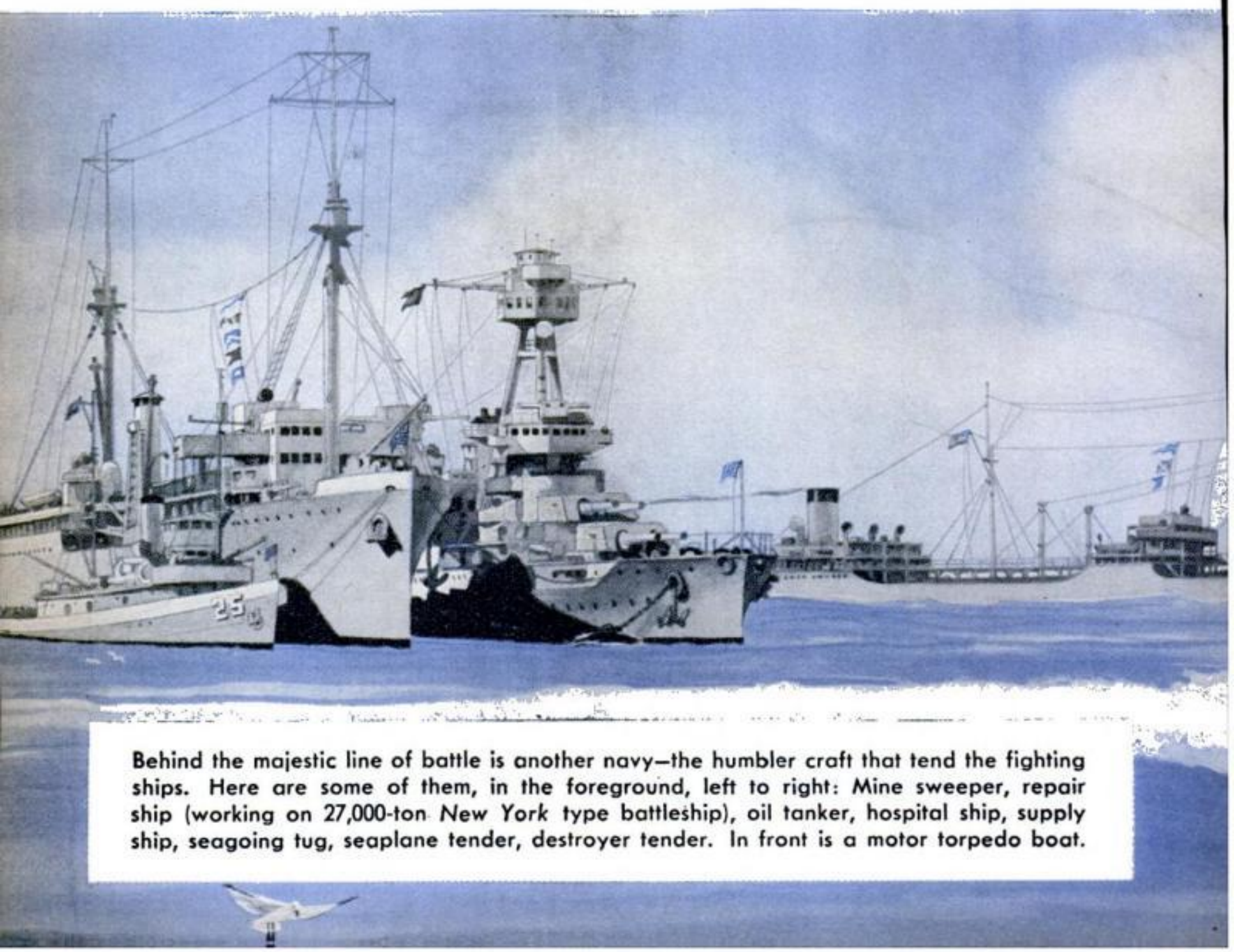
What distinguishes a battle cruiser from a battleship of equal gun power is superior speed, gained at the sacrifice of a battleship's massive armor. And now that engineering advances have given modern battleships what used to be considered battle-cruiser speed, the latter will have to be stepped up in turn. When the new 35,000-ton German battleship *Bismarck* met England's 42,100-ton battle cruiser *Hood,* since 1920 the world's largest warship, the contest was equal in guns and speed—but the *Hood's* armor failed to stop a shell that exploded its magazine and sank it. Presumably the new American battle cruisers, capable of destroying pocket battleships and cruisers, will have exceptional speed to keep out of the way of more powerful adversaries—which will have to be dealt with by our battleships.

Arrangement of big-gun turrets offers a striking example of changing naval designs. For American battleships, which formerly carried equal armament fore and aft, the *North Carolina* class represents a new departure. It concentrates two thirds of its guns in forward turrets, giving added fire power on the offense.

Comparison suggests itself with the new 35,000-tonners of foreign design. Italy's *Littorio* class has a similar arrangement of turrets, but inferior armament—nine 15-inch instead of 16-inch guns.

England's *King George V* class adopts a different method to bring the most intense gunfire forward. Quadruple 14-inch gun turrets fore and aft are reinforced by a

## AUXILIARY SHIPS BACK UP THE FIGHTING FLEET



Behind the majestic line of battle is another navy—the humbler craft that tend the fighting ships. Here are some of them, in the foreground, left to right: Mine sweeper, repair ship (working on 27,000-ton *New York* type battleship), oil tanker, hospital ship, supply ship, seagoing tug, seaplane tender, destroyer tender. In front is a motor torpedo boat.

pair of guns of the same size in a second forward turret.

France's ill-fated *Richelieu* class represents an all-forward turret arrangement, unique except in Britain's smaller *Nelson* and *Rodney*. Even before the war, British naval maneuvers demonstrated its dangerous weakness in leaving the stern unprotected. The battered *Richelieu,* last reported in use as a floating battery, mounted eight 15-inch guns in quadruple forward turrets.

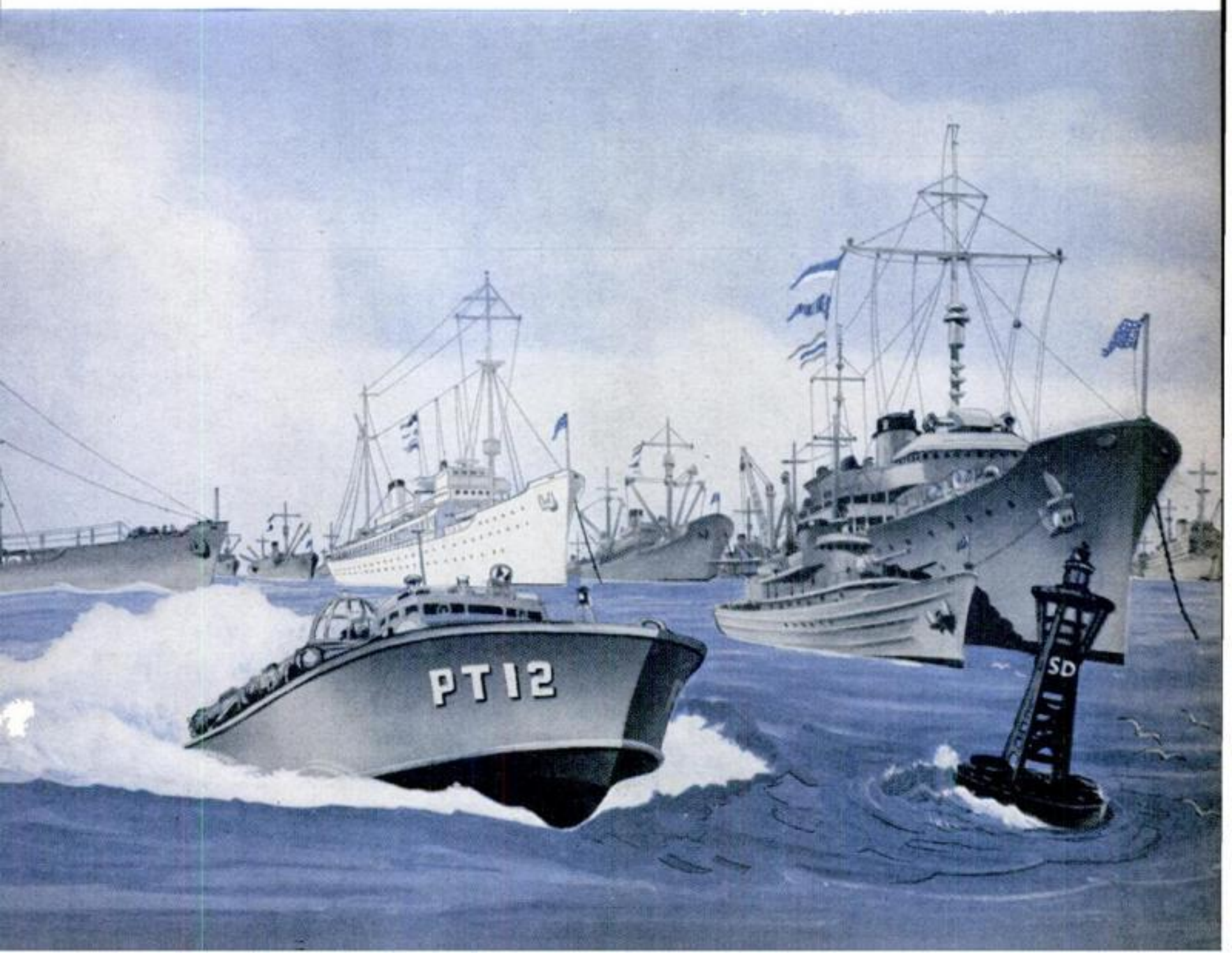
Germany's new *Bismarck* class carries the same armament in two turrets forward and two aft. Japan's smaller *Nagato* class mounts eight 16-in. guns, similarly distributed.

A glance over these figures will clearly show the superior armament of the U. S. 35,000-tonners, with Britain's a good second, as measured by the total power of their guns. The American ships even have the greatest total diameter of guns; and a projectile's bulk increases so rapidly with diameter that a 16-inch shell weighs half again as much as a 14-inch shell.

In the U. S. battleship program, four more of the *North Carolina* class are building, and due for completion next year. They will be followed by six even mightier 45,000-ton craft of the *Iowa* class. These 880-foot ships, designed to equal or outclass Japan's much-rumored vessels of 40,000 tons or more, will use their added tonnage for speed. Keels have been laid for four of them. Thirty percent of their steel work will be welded, saving still more weight for propelling machinery, which is rated at the unheard-of figure of 200,000 horsepower —which is nearly twice that of the *North Carolina.*

If that seems like something, hold your hat. Five more U. S. battleships of the *Montana* class, all contracted for, will displace 58,000 tons apiece. Superdreadnoughts seems a mild word for them. Probably too gigantic to risk launching by sliding down shipbuilding ways, they may be set afloat in special shipbuilding basins—another subject upon which the Navy prefers not to elaborate. For armament, twelve 16-inch or 18-inch guns are talked about. To naval architects these will be "dream ships," virtually ending decades of compromise in apportioning weight for guns, armor, and propelling machinery. Hulls of such monster size will carry all that could be desired of each. The result will be the long-predicted "ultimate" or ideal battleship, the monarch of the high seas.

And, as someone has said with grim humor, "People understand battleships."



# Army's Nerve System—

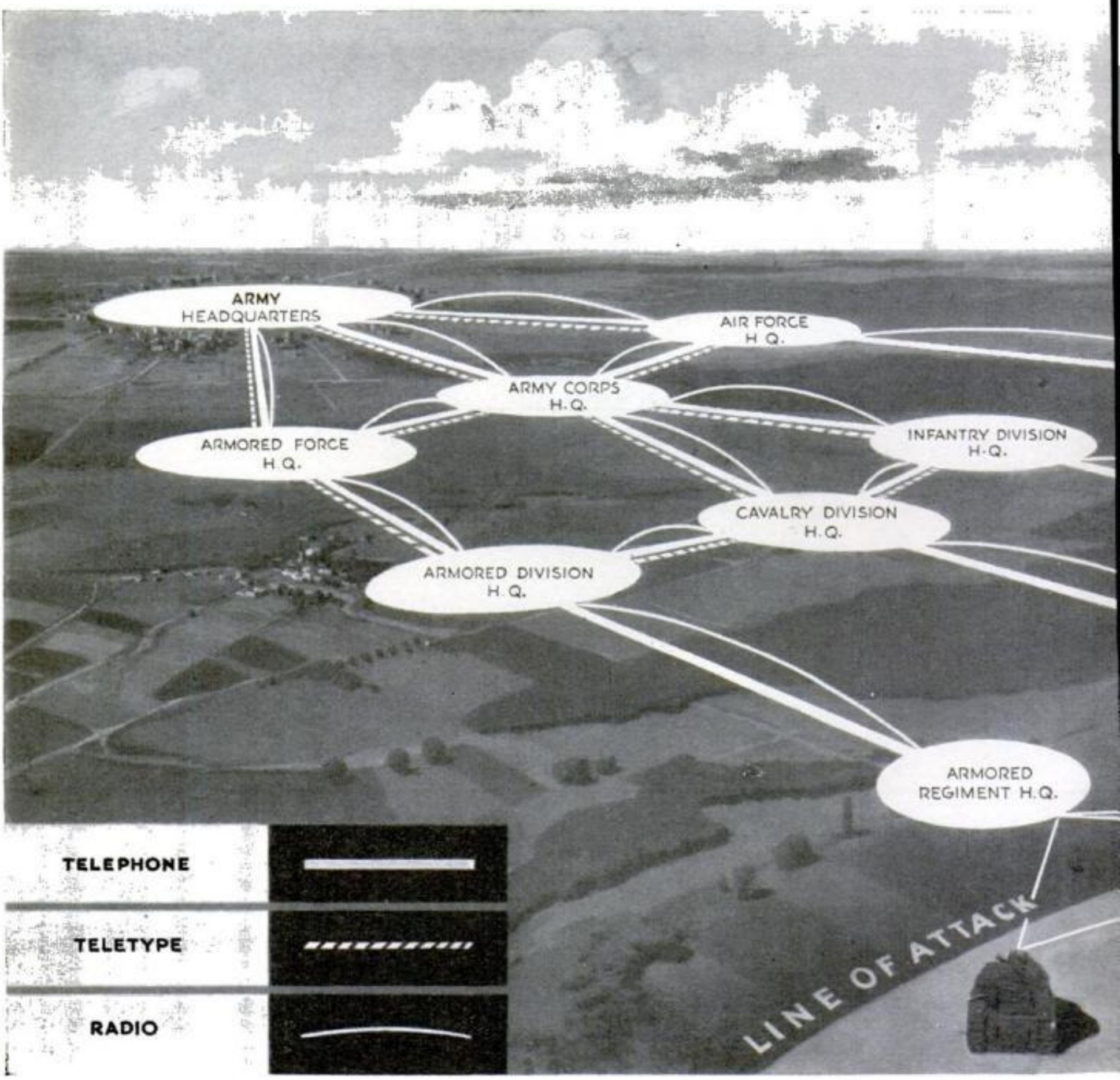
## SPEEDS TEAMWORK OF FAST-MOVING FIGHTING MACHINES

By HICKMAN POWELL

THE heavy tanks and dive bombers hit the line, smash an opening. Through the gap rush the armored divisions, the light and medium tanks and armored cars, fanning out, a fast backfield running interference for the infantry.

Fifty miles, 100 miles and more a day the mechanized columns speed over the vast grid map of battle. Their slashing end runs flank the enemy at 35 and 40 miles an hour. In Flanders, France, Greece, Libya, the dashing pace of modern war has come more and more to resemble football in a broken field.

But the comparison breaks down completely at one point: there is no time out for

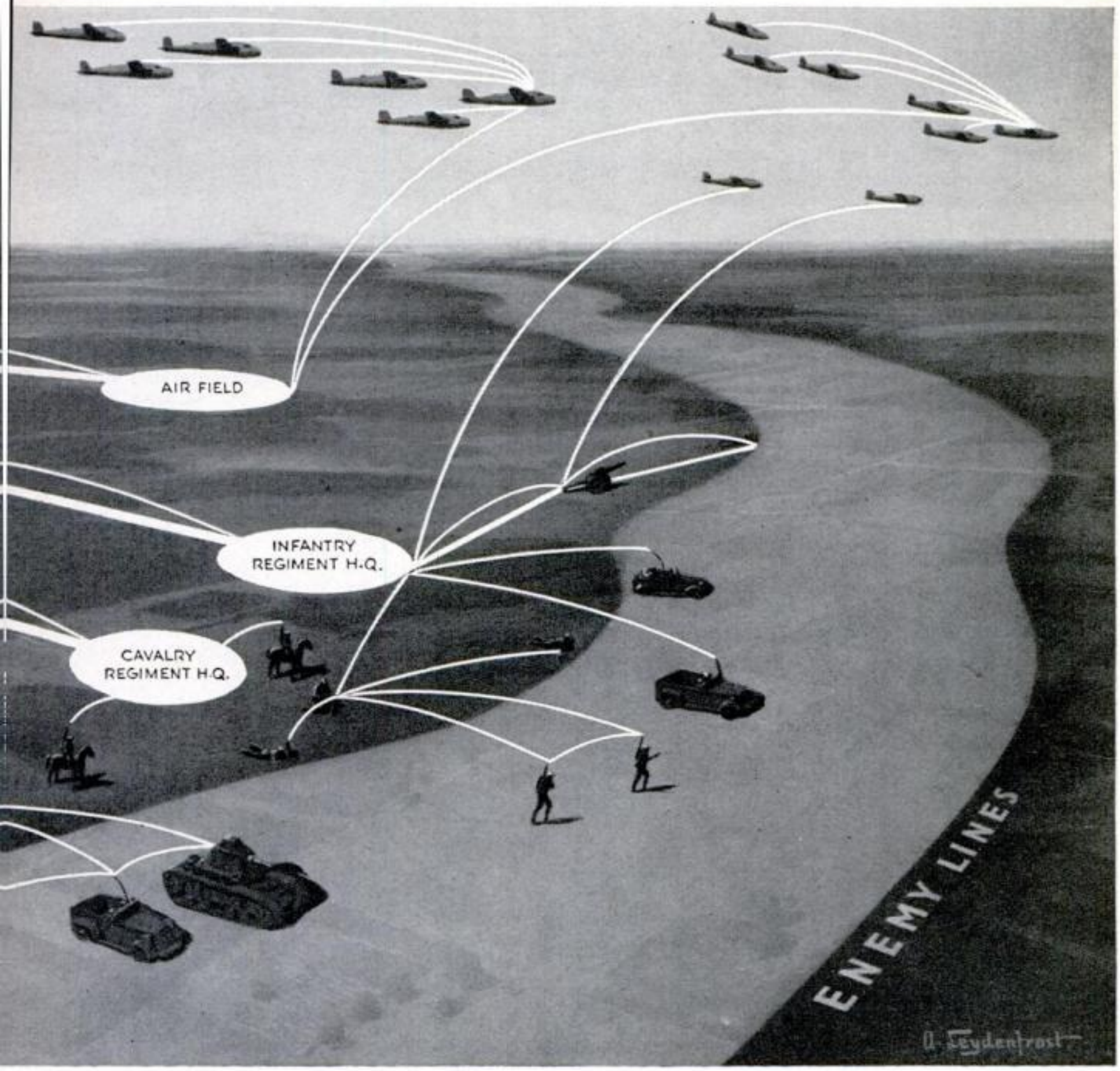


a huddle between plays. Signal communications, the army's nerve system, must be maintained at breakneck speed continuously. Observation planes, bombers, scout cars, tanks, artillery, infantry must remain in quick, instant contact with the high command; otherwise an integrated, intelligent striking force becomes a disjointed rabble.

The marvels accomplished by the German Army in the last two years have set our political orators shouting for tanks, planes, guns—a cry with which everybody agrees. But every military man knows that the real marvel of the German assault has not been merely its preponderance in engines of war, but also the precise coördination with which this vast amount of equipment and manpower was used.

The Germans learned their lesson in 1914. Entering the first World War with a primitive signal corps comprising only nine battalions of telegraph troops, they failed to carry out their original assault according to plan, largely because their communications broke down. No such fault developed in 1940, though lines of communication were

How the Signal Corps might spread its communications nets to connect the various elements in an attack. Headquarters of larger units in the rear are hooked up by teletype, telephone, and radio; divisional and regimental headquarters, by telephone and radio. Men in action receive orders and make reports by radio, through sets in tanks, scout cars, observation posts, or "walkie-talkies." The latter work only with other walkie-talkies and have contact with regimental headquarters through infantry outposts. Observation planes work with guns, spotting shots, or with regimental headquarters to report enemy movements. Bomber and pursuit-plane squadron leaders may communicate with air-force headquarters directly or through air field



stretched far beyond what seemed their breaking point. That army's nerve system extended to its very fingertips, as exemplified in the attack on Fort Eben Emael. The sudden fall of that stronghold was one of the shocking mysteries of the attack on Flanders, but it became less mysterious when word came through that the assaulting engineers, tanks, and air force were in contact by radio throughout the attack with parachute troops landed inside the fortifications. Even with this intensive use of radio, wire channels were not neglected. Right behind the tank columns came the signal trucks, unrolling their telephone and telegraph wire.

Today the Signal Corps of the U. S. Army, under Major General Joseph O. Mouborgne, is engaged in an expansion program big and complex enough to wrinkle the brow of any industrialist. America's vast prospective motorized and mechanized Army must be provided with a communications system of multiplicity and complexity undreamed of in the World War. For every time you double the speed and mobility of a military outfit you multiply its communications problem. And the new miracles of radio—used only when more secret message channels are not available, must be superimposed on all the old, sure methods—telegraph, telephone, pyrotechnics, messengers, and pigeons.

Some notion of the task involved may be obtained by merely glancing at the radio equipment of a single armored division. The United States armored division is at present composed of approximately the following forces, all carried by armored vehicles:

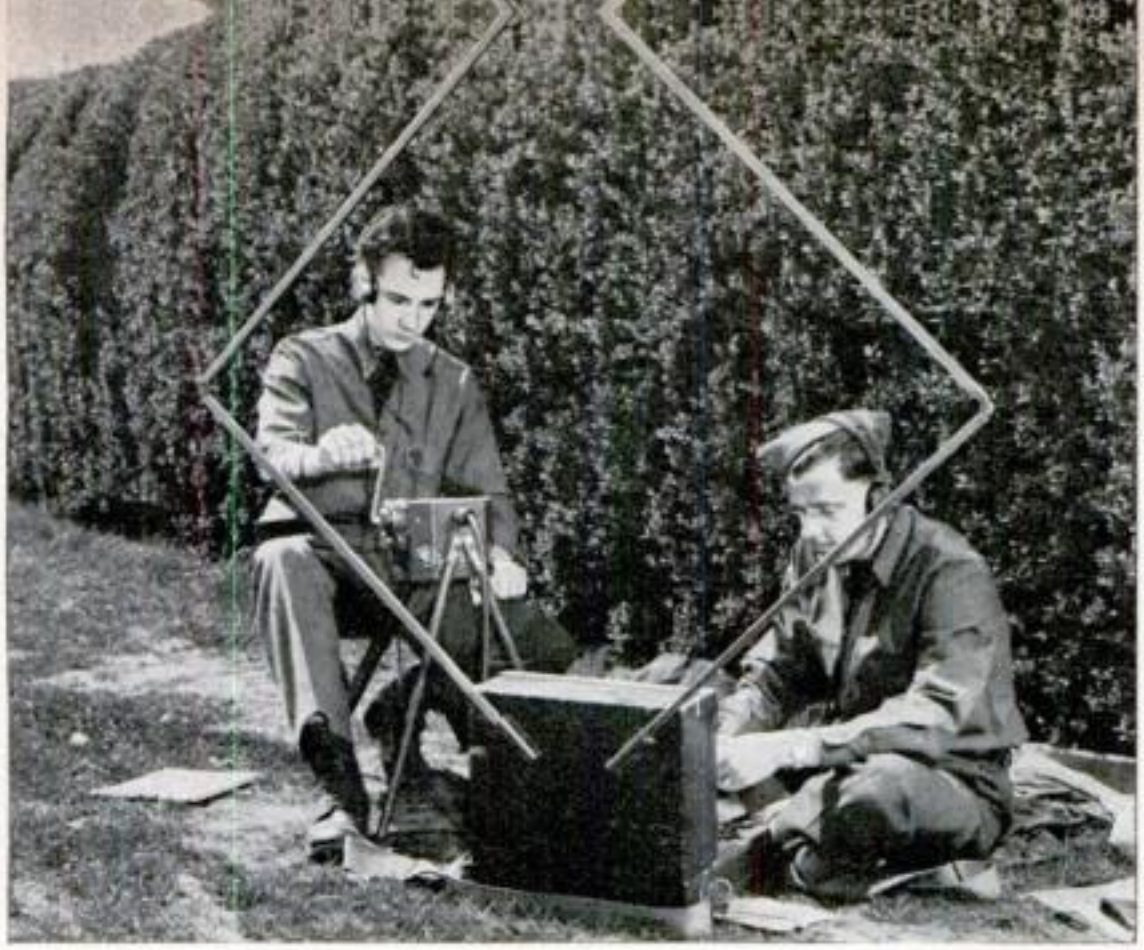
A headquarters (in three echelons, which in operation may be separated by as much as 60 miles); 1 reconnaissance battalion; 1 armored brigade of three tank regiments, two light and one medium; 1 infantry regiment; 1 battalion of field artillery (four batteries); 1 battalion of engineers; 1 signal company; and service elements.

To perform its mission, and make it instantaneously responsive to commands while operating at high speed, this aggregation of striking power has basic signal equipment of about 700 radio sets, not counting those of coöperating observation planes and dive bombers. Each commanding officer is connected with his subordinates, and coöperating units of infantry, artillery, and air force maintain liaison, through a system of nets tuned to separate radio frequencies.

The number of nets required for this system is a total of at least 41, plus a number of ultra-short wave channels for short-range voice transmitters within infantry and artillery units. Remember that this is just for one division, a relatively small part of a modern field army. Take an armored corps of several divisions, follow it up with motorized divisions and divisions of foot soldiers; then put a hostile army in the same field, also using radio; and you have an air traffic problem which makes the difficulties of the F.C.C. with wave lengths seem like child's play.

Only the most rigid *(Continued on page 216)*

WALKIE-TALKIE aerial pulls out to six-foot length for stationary use and telescopes to 18 inches for walking. The outfit rides in a pack, weighs 25 pounds

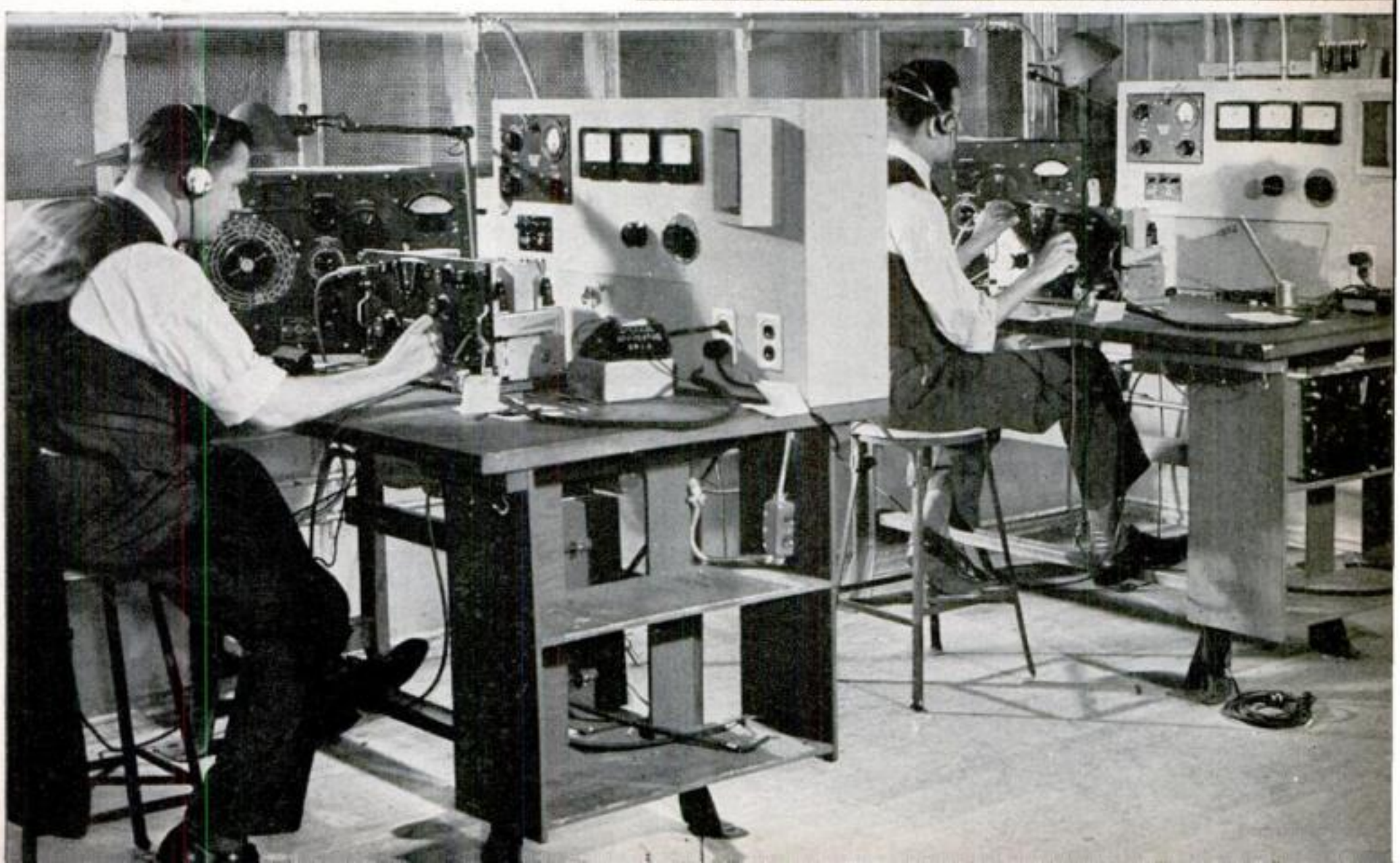


FIELD RADIO for battalion-to-regiment work has five-mile effective range, sends code. Hand generator supplies power. More powerful sets are used by the larger units

FIELD TELEPHONE, at upper right, serves command and observation posts. Has its own battery and generator for ringing stations. Works efficiently up to 20 miles

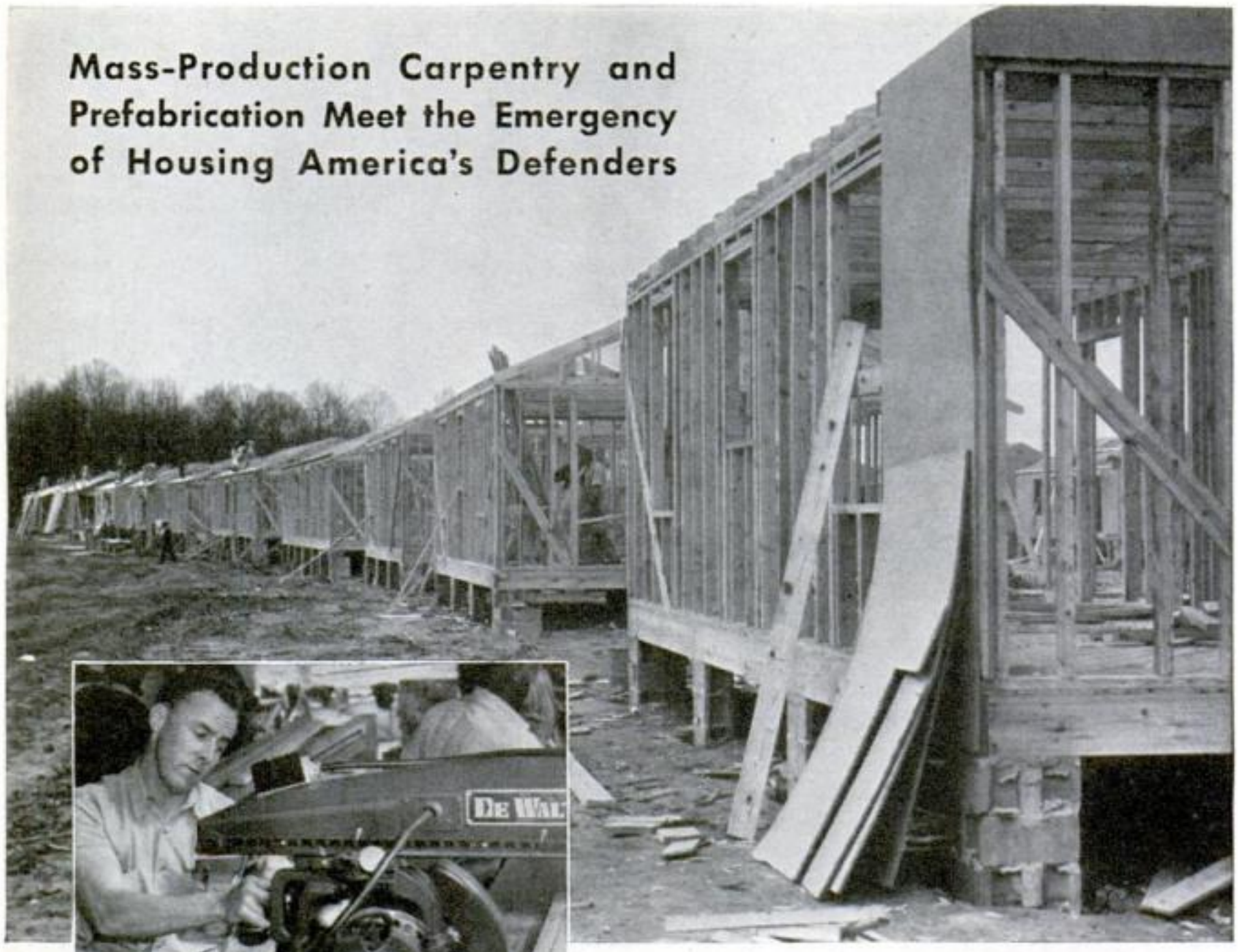
FIELD SWITCHBOARD at right is 12-circuit size commonly used at regimental headquarters. Carries own batteries and can handle messages up to about 15 miles

ON THE INDUSTRIAL FRONT America needs skilled radio technicians to build and service the countless instruments we must have to equip our fast-growing Army



# Assembly-Line Cities

## Mass-Production Carpentry and Prefabrication Meet the Emergency of Housing America's Defenders





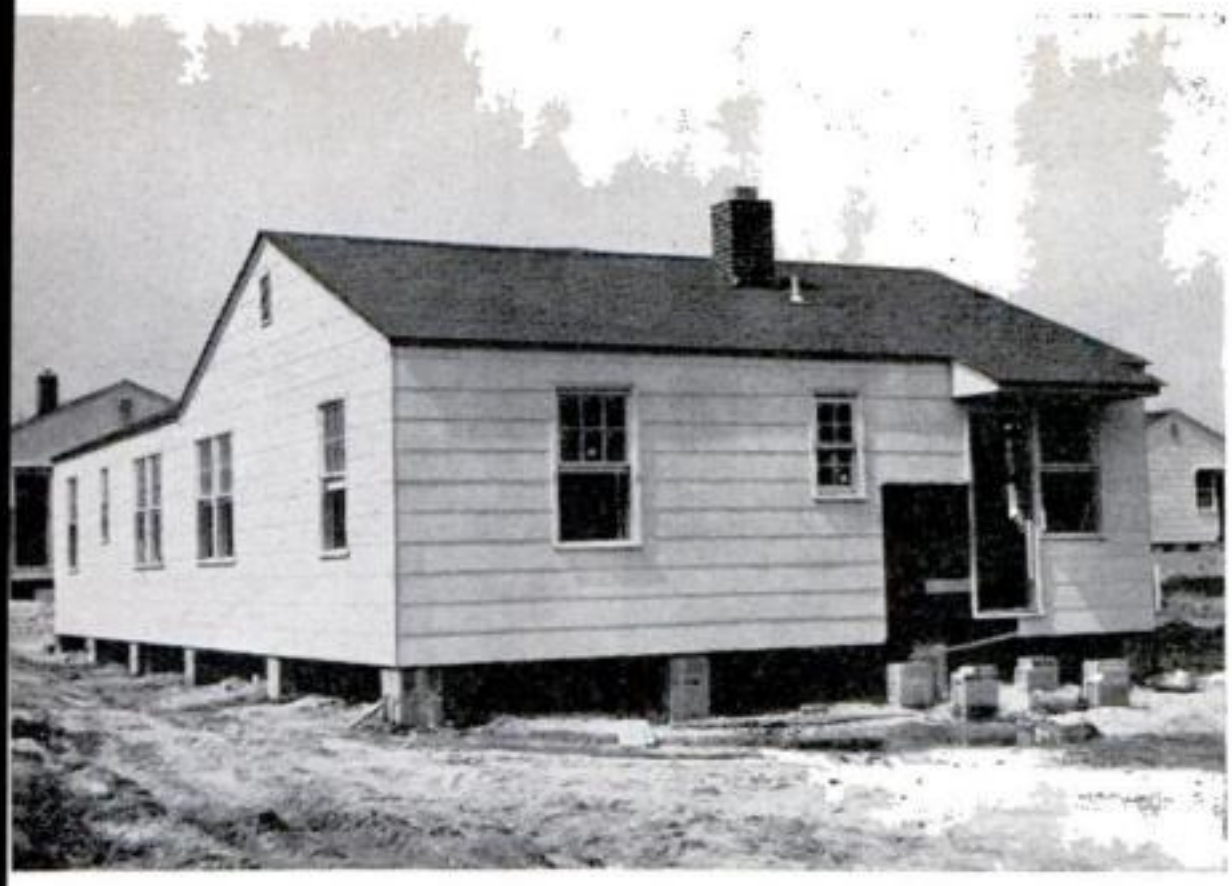
Squads of workers moved down the line erecting these houses near the Aberdeen Proving Ground from boards cut at the site by sawing machines

By WALTER HOLBROOK

WHOLE CITIES have been put together the last few months with only a rubber mallet, screw driver, and wrench for tools, and plenty more are rolling off the assembly lines. Prefabrication was largely dream until France fell, and this country decided it wanted a lot of shooting irons and fixin's right quick. It's real enough now, and growing like corn in Iowa.

Even mass production could not spew out the soldiers and planes fast enough, but since it's the nearest thing to Aladdin's Lamp we have, the nation was soon mass-producing everything but brains, and it probably would do that if it could figure out a way. The swelling Army had to have a place to sleep, eat, and go to the movies, to write the girl back home and entertain that little honey down the road, maybe to go to church. So did the workers who began streaming into the factories in answer to frantic calls for more and more men. For ten years the nation had been putting off most of its home-building, and the few houses vacant in Detroit and San Diego, Wilmington and Seattle soon were filled. Workers threatened to quit because they could not find a place to live. The Government began building pretty much in the old-fashioned way, but as those screams multiplied it turned first to assembly-line carpentry, then more and more to prefabrication.

The Army let its first contracts within 24 hours after the President, on July 31, 1940, authorized the use of part of his

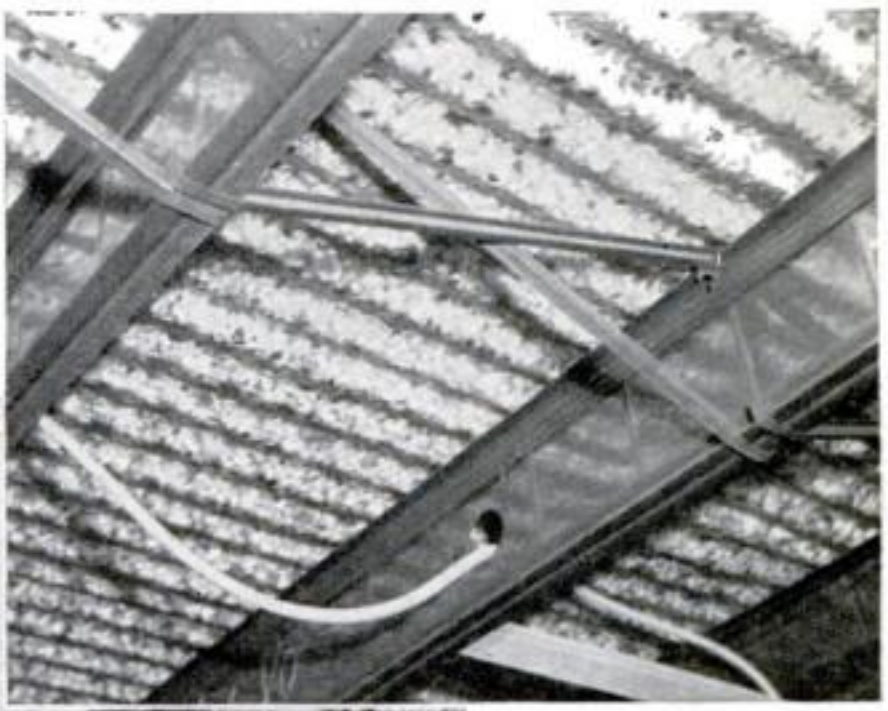


A one-family home run up for a civilian employee of the Edgewood Arsenal. It is one of 250 built by field-assembly methods

emergency funds to start building camps for the first National Guard divisions to be called into Federal service. Less than 11 months later it had run up 44,599 buildings, not counting homes for married enlisted men, and had housed all the 1,177,000 men that Congress ordered. During the same time the Navy had set up 17,105 rooftrees for married sailors and civilian employees, and Government bureaus had coined 19,000 homes for industrial defense workers and the Army's married enlisted men and civilian personnel. Altogether, houses have been built, or will be built, in 543 different projects, all the way from Kodiak, Alaska, to the Panama Canal Zone, and from Greenland to Honolulu.

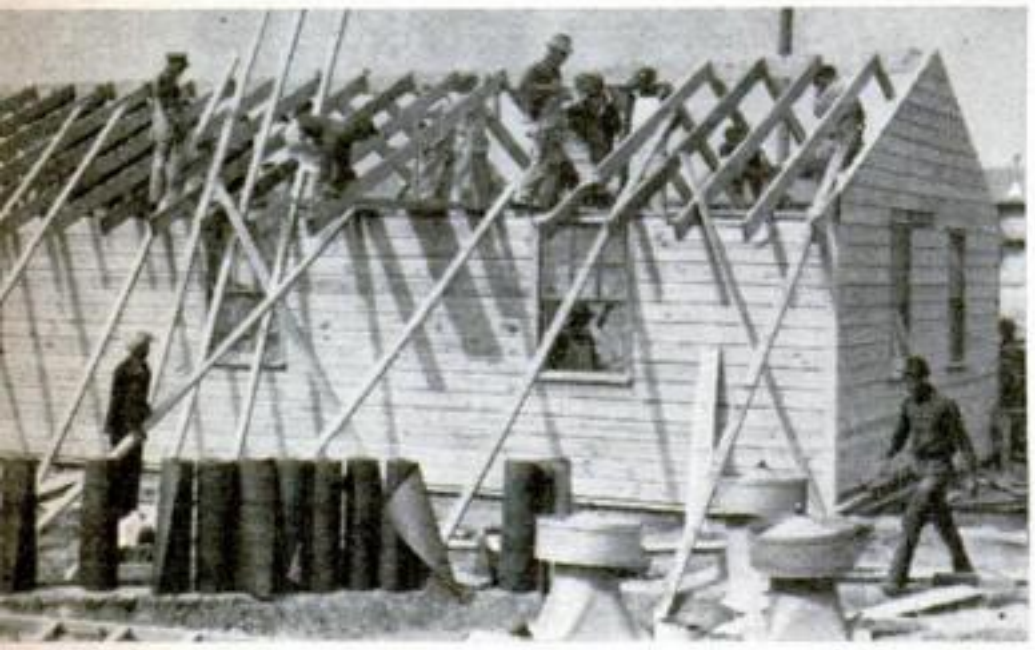
The Army is quartering 475,000 men in the South in wooden-floored tents. These could be set up quickly, and most of the National Guardsmen and the first selectees were sent to these southern camps. To house the remainder of the 1,177,000, the Army put a standard, 63-man wooden barrack and latrine combined on a series of field assembly lines. Twenty or more crews of carpenters, laborers, plumbers, and electricians, each numbering from eight to 40 men, worked in turn on each building.

In this way, some of the barracks, all of them what the Army calls semi-permanent, were built in six days, complete with cen-



The steel beams of this multi-family unit at Norfolk, Va., brace the corrugated frame for the second-story floor


Asphalt shingles cover the steel frames of the Norfolk apartments for Navy men. The rent is from $17 to $33



tral heating and air conditioning. Put up the same way were 33 other buildings, from mess halls to theaters and hospitals, standardized for all 185 camps, North and South.

The Navy turned to partial prefabrication. Tennessee Coal, Iron and Railroad Co., a subsidiary of U. S. Steel, forged all the structural parts for the Navy's biggest project, 100 twelve-family, two-story apartment buildings for shipyard workers at Newport News, Va., and also for 50 two-family houses for enlisted men at the Marine Corps Base at Quantico, Va. Strans-Steel, a unit of Great Lakes Steel Corp., in turn a subsidiary of National Steel Corp., supplied similar steel parts for the Navy's second biggest project, 1,042 homes for enlisted men at the Naval Operating Base at Norfolk, Va.

These companies stamped out steel wall frames four feet wide and eight feet high, joists, rafters, roof trusses, and even steel panels for the roofs. After these steel bones were bolted together and to the concrete floor, the buildings were clothed in the usual way, with sheets of insulating wall board and asbestos shingles.

Factory production of these steel shapes, of course, had to wait on neither weather nor grading. So all but three of the Navy's 46 projects were going up before the end of January.

The armed services knew from the start how many buildings they would need, but Charles F. Palmer, an Atlanta real estate man who was named by the President a year ago to coördinate defense housing, and the Government's various housing agencies had first to take a census to determine where and how much new building was needed. Demountable, prefabricated houses were thought of first merely as a way to avoid a repetition of the ghost towns which haunted the nation after the last war. Last August it was decided, as an experiment, to ask a number of prefabricators to set up 650 demountable houses at Indian Head, Md., thirty miles south of Washington, for workers at a powder plant to be built by Du Pont, and in March and April contracts were awarded to eleven companies. The Government supplied plans for one and two-family buildings, each dwelling to consist of a living room 12 by 15 feet, kitchen, bath, and two bedrooms.

While another contractor prepared the sites, the prefabricators built their houses

Built on the ground in panels, company storehouses like this were thrown up in as short a time as 54 minutes. Note that walls were finished inside and out, including windows, before they were raised into place, rafters were added and the roof was rolled on

The Army's standard, 63-man barrack. It has central heating, air conditioning, plumbing

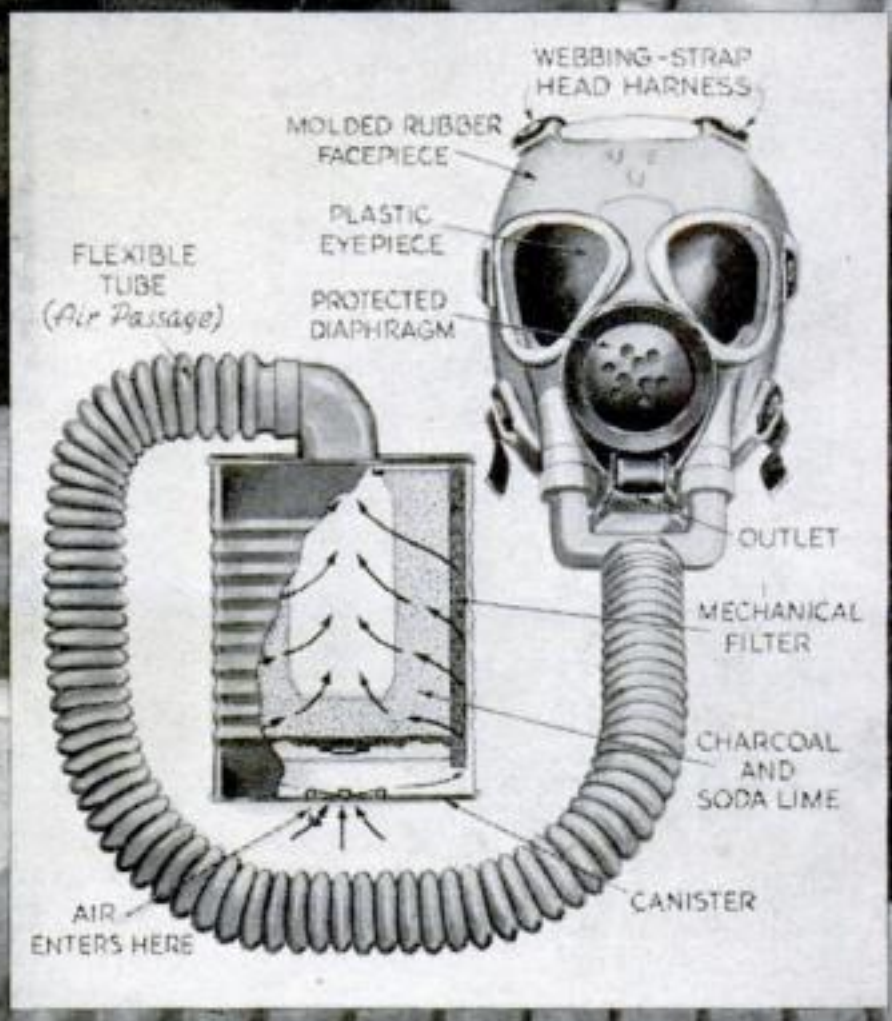
Below are the reën-forced concrete pillars to support barracks at the Edgewood Arsenal

The interior, at inspection of quarters. The duct circulates fresh air besides providing heat

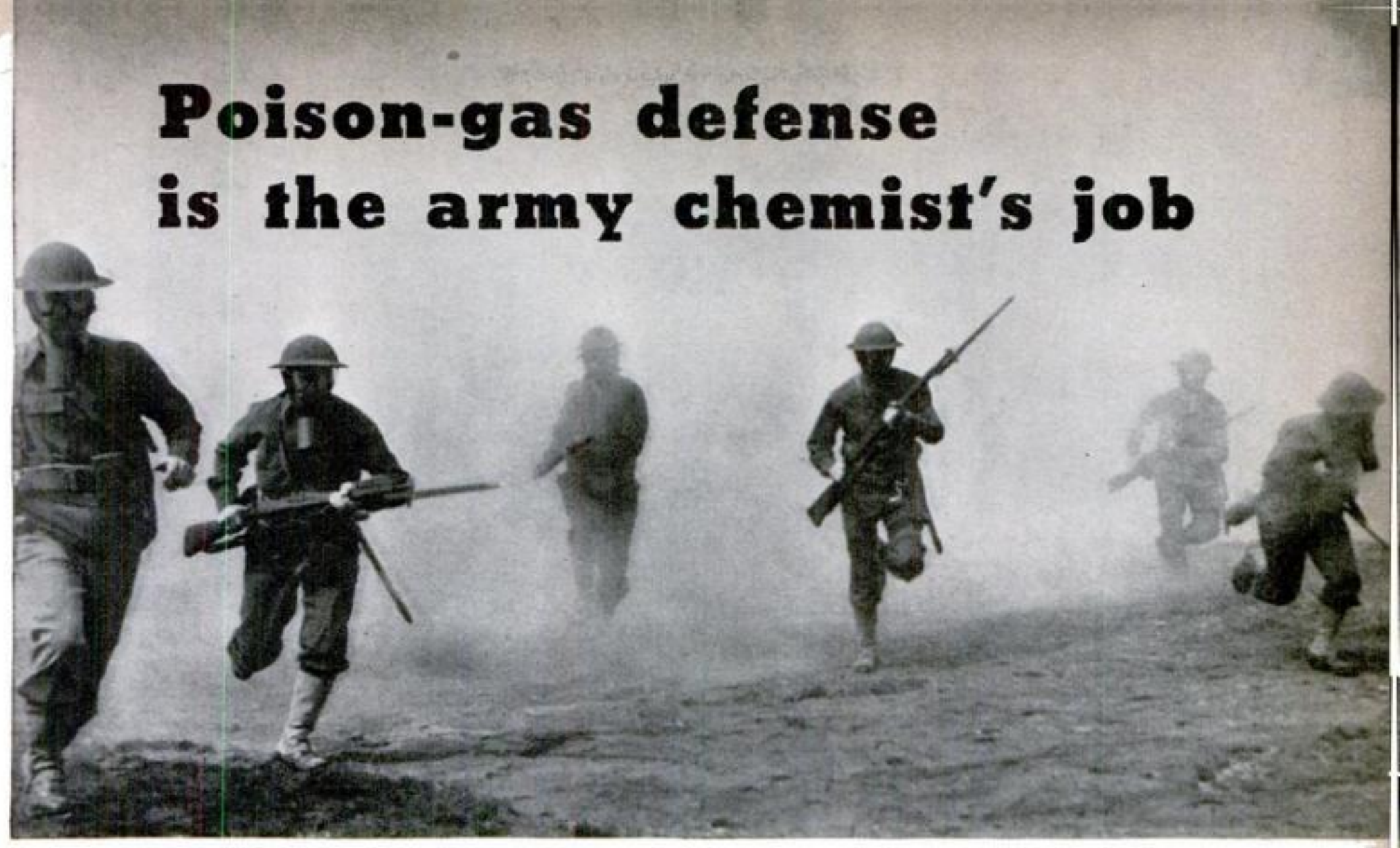
in their own factories, and in May they were erected. Three faced theirs with steel panels, one with Homasote, a board made of old newspapers pressed together, and the others with weather-proofed plywood. All but one shipped the houses in panels, eight feet high and from four to 14 feet wide. The exception, PHC Housing Corp., of New York City, sent single numbered pieces.

Like nearly all the others, however, the PHC houses were erected with only a rubber mallet, screw driver, and wrench. Sawing, planing, and nailing was done at the factory, by machines. There, too, the houses were painted, with a spray gun, and the inside walls stained, painted, enameled or papered. Construction was dry, except for cement pillars, and most of the contractors finished the inside walls with Sanitas, a patented wall covering made by the Standard Coated Products Corp. One company, Lockwall Houses, Inc., of New York City, set its houses on adjustable steel piers, which can be horsed up and carried along when the houses are taken apart and moved after the war. This company fastened its wall panels together with a patented lock, similar to a screen-door latch, except that it is inside the wall, in a dowel. A smal' hole, later hidden by a flap of Sanitas, permits insertion of a special wrench. Most of the prefabricators fastened their panels together with nuts and bolts. PHC, for which the chief architect is Harvey Wiley Corbett, the senior architect in the building of Radio City, used metal clips as well.

Federal mortgage appraisers have rated similar houses, erected by several of the same prefabricators, as at least as good as conventionally built homes, and they are a fifth cheaper. The Government did not wait until its experimental houses were built before it began ordering on a larger scale, and to stay put as well as be poised for moving. *(Continued on page 211)*



# Poison-gas defense is the army chemist's job



Smoke screens and gas defense are both in the field of the Chemical Warfare Service. Smoke-making chemicals are packed in cans and set off by scratching a fulminator cap

*this threat, for an attack with gas would be expected to meet with the greatest success when employed against great centers of population.* POPULAR SCIENCE *here presents a discussion of this country's gas defense equipment and technique by Lieut. Col. A. M. Prentiss, author of "Chemicals in War," the United States Army's standard textbook on the subject.*

**By LIEUT. COL. A. M. PRENTISS**
General Staff Corps, U. S. Army
Authority on Chemical Warfare

*EVERY nation in the world is prepared in greater or less degree to defend itself against gas, a weapon to which no belligerent found it advisable to resort in the first 18 months of the war. The United States aims to be in the ranks of the fully prepared, for gas is an arm which can be introduced into a conflict at short notice and under favorable conditions is highly effective against an unprepared foe. It is one of war's bugaboos which might stalk abroad at any moment.*

*Since the outbreak of the war every city in Europe has been prepared to deal with*

Tests on a dummy head show how much "pull" it takes to draw air through the canister of a diaphragm mask. Ducts lead fresh air against the eyepieces to prevent fogging

Gas covers a far greater area, pound for pound, than high explosives or other impact weapons. Thus, one medium bomber, carrying four 550-pound bombs filled with a non-persistent gas such as phosgene, under favorable conditions can establish in a single flight an effective concentration over four circular areas, each about 300 yards in diameter. At this rate, a squadron of twelve bombers in one flight can cover a square mile with such a concentration that every unprotected person would become a fatal or serious casualty.

If persistent gas such as mustard were employed in small (22-pound) bombs, one medium bomber could create in a single flight 100 centers of contamination, each approximately 40 yards in diameter. The area


SMOKE AND MARKSMANSHIP
Trials have shown that troops firing out of a smoke screen are at a big disadvantage against troops firing into it, because the effectiveness of their fire is reduced much more

thus covered (126,000 square yards) is the equivalent of five average city blocks. If the persistent gas were sprayed, instead of dropped in bombs, each plane could cover an area a mile long and 1/6 mile wide, and one squadron of 12 bombers, an area of two square miles. While the concentrations thus produced would cause but few deaths, nearly every unprotected person in the area covered would become a casualty.

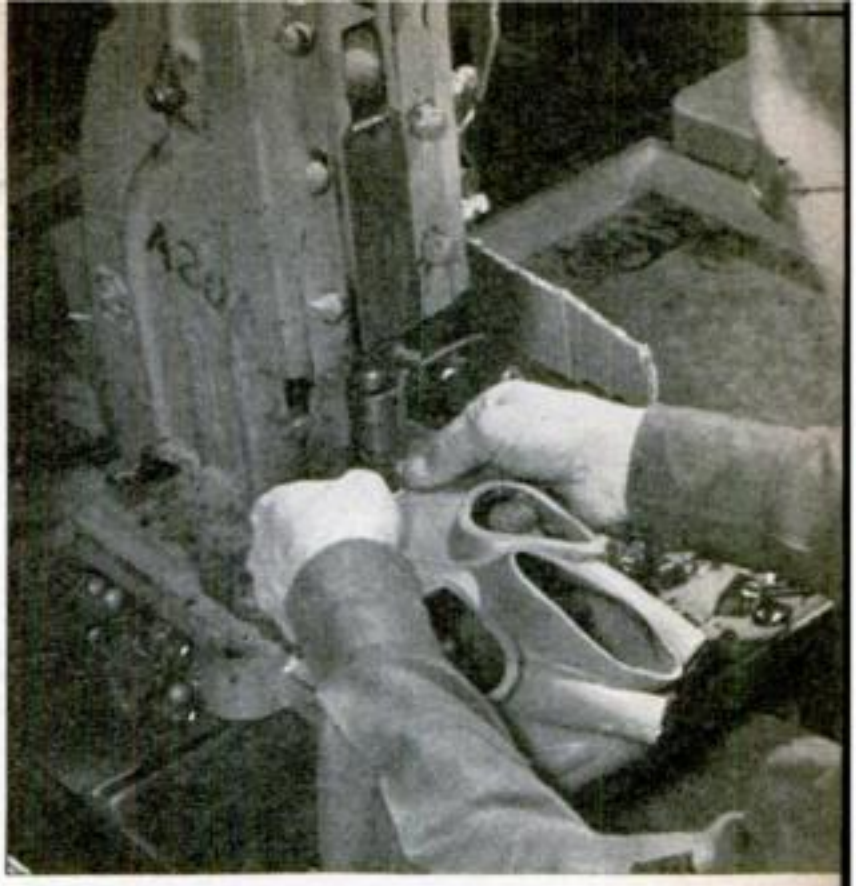
In addition to its greater coverage, gas also would have a very marked searching effect. By filtering through cracks and crevices and flowing into every nook and cranny, it reaches every part of the area covered, even places protected from the fire of other weapons. Persistent gases (such as mustard) also have a long duration of action and remain effective over periods of time which vary from several hours in summer

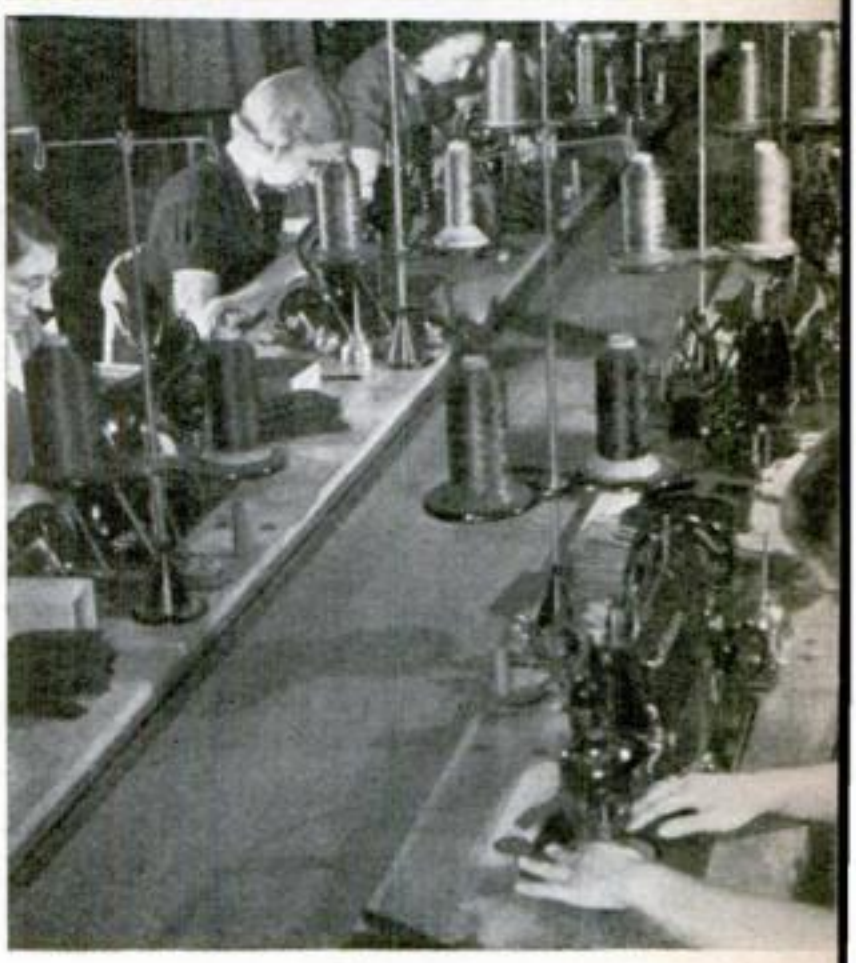
TRAINING MASK has a small canister attached to facepiece

SERVICE MASK is the standard article designed for combat troops

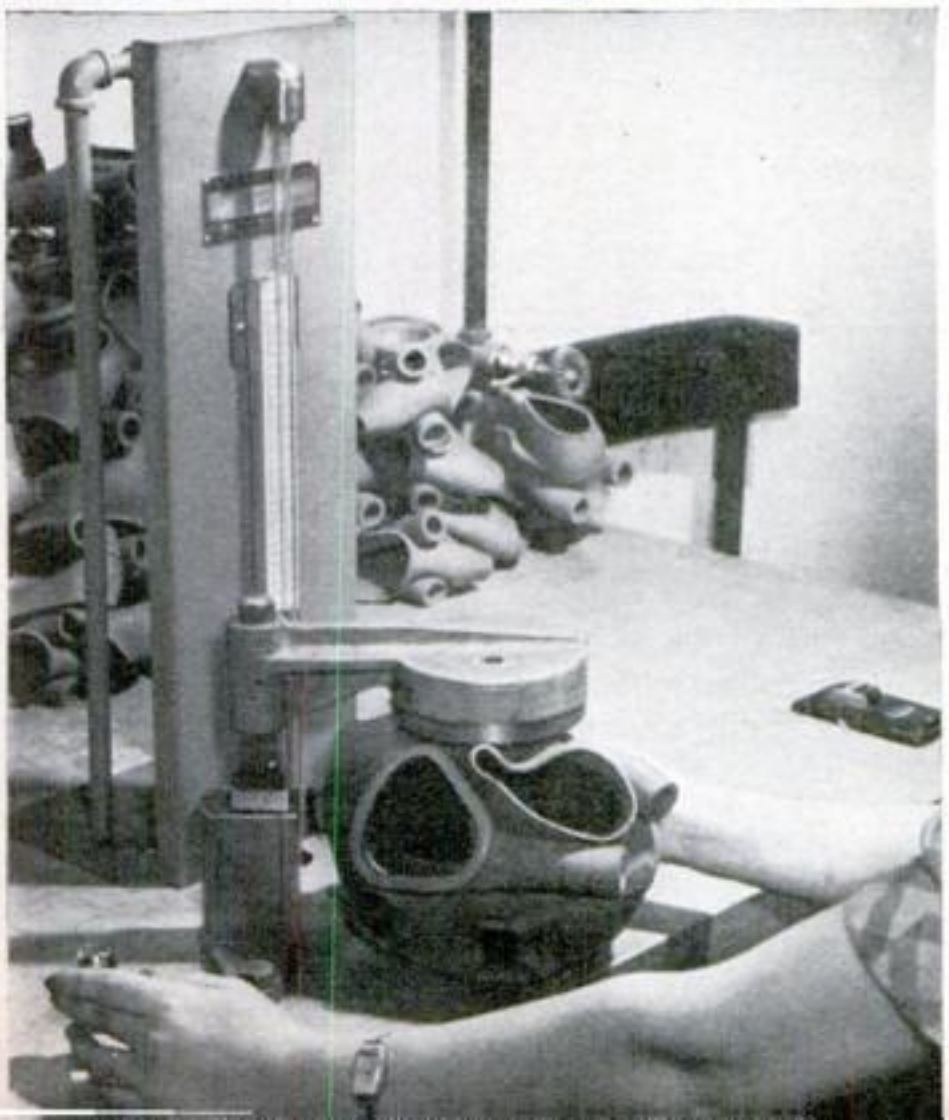
DIAPHRAGM MASK. Its .004-inch diaphragm permits talking

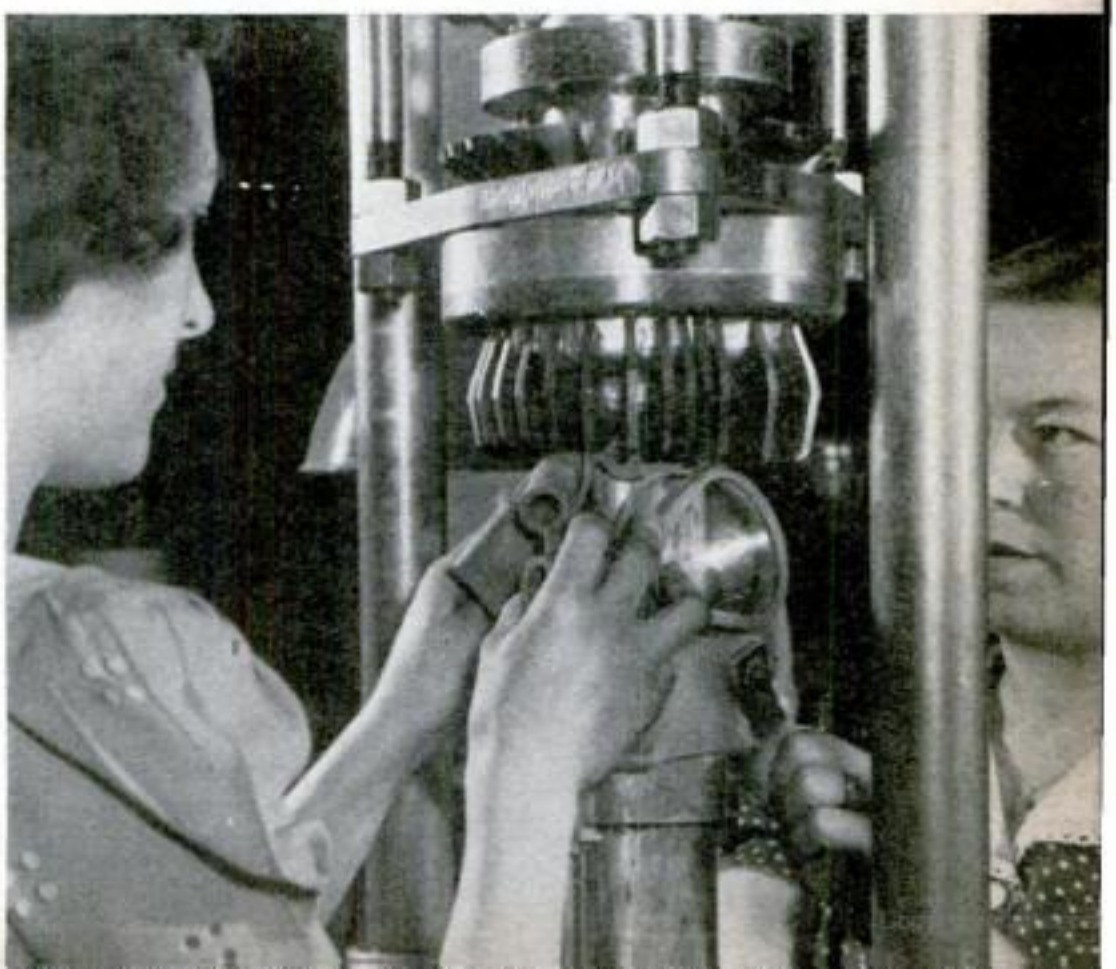
ASSEMBLING DIAPHRAGM MASKS at Edgewood Arsenal, Maryland. The Army enlisted man seen at upper right, stamping rivets to hold webbing straps, is learning how masks are constructed so he can serve with a repair unit in the field. The women in the picture at the right are sewing the straps





AIR-TIGHT EYEPIECES are produced by inserting metal frames over the plastic windows and crimping them onto the molded rubber facepiece on the machine below. To test the tightness of the fit, vacuum is applied with the device at left. A leak makes liquid fall in the glass





to several days in winter. Many gases also have high powers of penetration. Thus mustard gas readily goes through all ordinary clothing and even through leather and rubber; it also quickly soaks into wood and concrete and is exceedingly difficult to remove.

Finally, gas has a powerful psychological effect because it is usually invisible and its powers and limitations are not generally understood. The human mind instinctively fears the unseen and unknown, and the harmful effects of gas are thus greatly magnified by the imagination. This moral effect is of special importance in gas attacks on the great cities, as it may easily lead to widespread panic and demoralization of the civil population.

Owing to the characteristics mentioned above, gas is a powerful defensive weapon. It may be quickly laid down by low-flying attack planes and chemical tanks in broad belts across a front to be defended and thus provide a serious barrier to enemy attacking troops which must traverse such contaminated zones. While it is, of course, possible to gasproof tanks and other mechanized vehicles, it is exceedingly difficult to keep them gas-tight under battle conditions and widespread casualties to mechanized troops would undoubtedly result from traversing gas-contaminated areas. Also, the wearing of masks and protective clothing materially reduces the combat efficiency of troops, especially where they are compelled to wear such equipment for many hours at a time of great physical exertion.

Wrapped in pliofilm, one of millions of masks being stored in the United States is packed neatly in an individual carton, ready for emergency use

Recognizing the seriousness of gas attacks, especially upon the large cities, every country in Europe has taken far-reaching measures to protect its army and urban population from this threat.

In addition to providing means for warning soldiers and citizens of impending gas attacks and educating them as to the nature of gas and what to do to protect themselves against it, chemical defense comprises three general measures of protection: (1) gas masks and protective clothing for each individual: (2) gasproof shelters or refuge rooms for groups of persons: and (3) decontamination of ground, buildings, and materials in contaminated areas.

The principal gas masks used in the American Army are the standard service mask for combat and the training mask for training troops. These are supplemented by the issue to certain troops of special types of masks, such as diaphragm and optical masks, which enable them to carry on their combat duties when masked.

The Army service mask consists of three principal parts: facepiece, canister, and hose. The facepiece is died out of molded rubber blank covered on the outside with a thin layer of cotton fabric which is vulcanized to the rubber. After cutting to exact size, the blank is folded and the two short edges are sewn together and taped with adhesive tape, forming a gas-tight seam which fits under the chin.

The eyepieces are made of shatterproof glass held in the facepiece by detachable screw-type retaining rims. The facepiece is connected to the hose by means of an angle tube made of die-cast aluminum which also forms the seat for the rubber outlet valve. Six elastic tapes (called the head harness) hold the facepiece against the face with a gas-tight fit.

Army service masks were formerly made in five sizes in order to fit any size or shape of face. Recently, however, a new-type universal facepiece has been developed which fits 95% of all sizes and shapes of faces. The five percent of men who cannot be fitted with a universal mask must still be furnished with special sizes (about four percent with small, and one percent with large sizes). Even though it does not fit all faces, the universal mask greatly simplifies the problem of manufacture, fitting, and supply in the field.

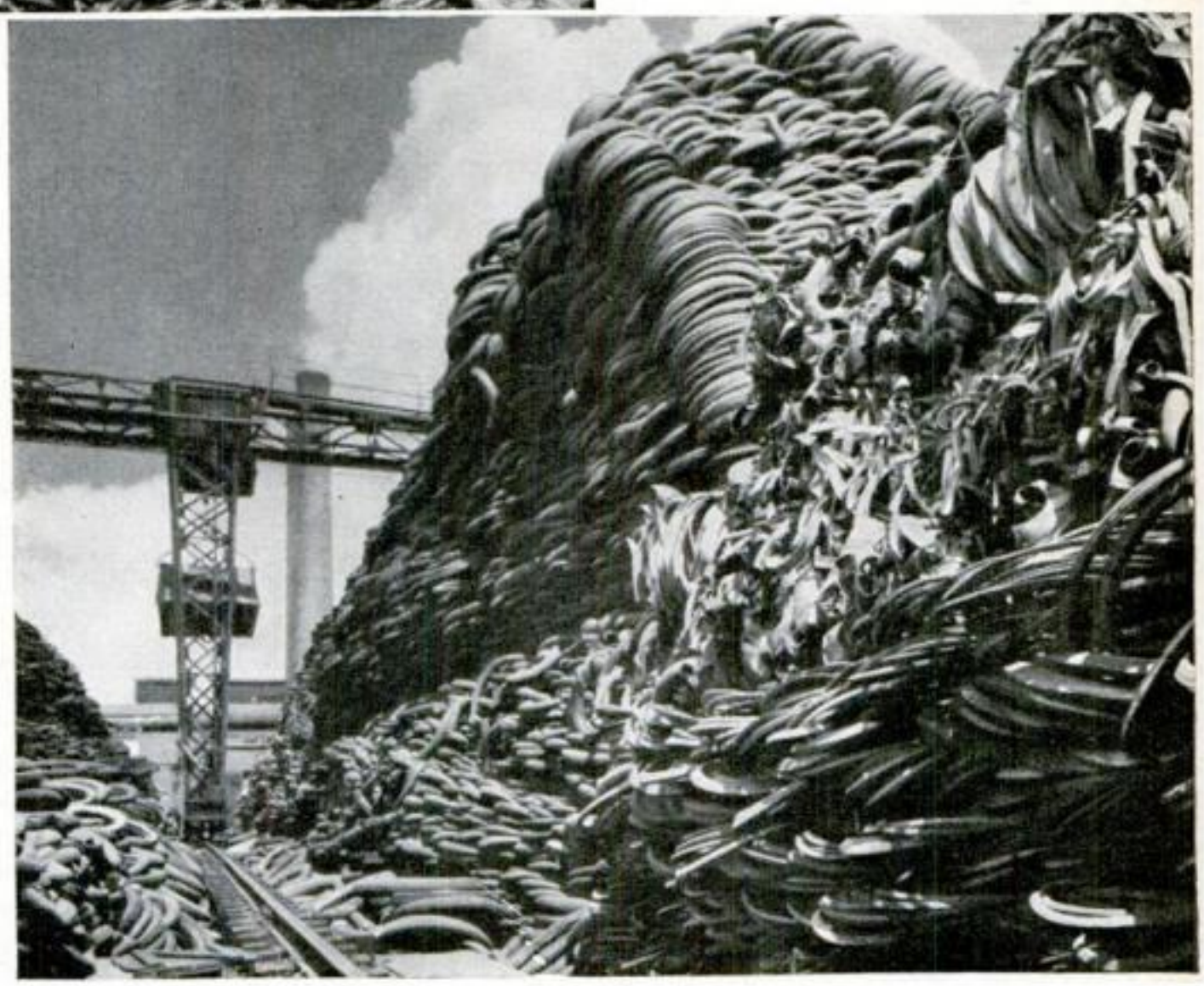
The canister of the Army service mask is a rectangular sheet-metal box which contains the chemical filling and the mechanical filter which remove toxic gas and smoke from the inspired air. The chemical filling comprises about *(Continued on page 212)*

# Chemurgy—a strong new weapon

By ROGER BURLINGAME

WHEN war threatens, a wise nation takes stock of its natural resources. It catalogs those raw materials of which it has an abundance, those it must import, those it must conserve, those it must do without. This last category brings up the question of substitutes.

Here, the United States is better off than it was in 1917. If our part in the last war had lasted longer, if our defense program had been larger, some of our lacks and scarcities would have become acute. Today, though we are faced with greatly reduced imports and possible shortages in metals, rubber, and



From old pine stumps, once only a nuisance in cut-over sections, chemurgy now extracts rosin and other products useful in fields from laundry work to road building

One pine-stump product, a terpene hydrocarbon, is helping to eke out our supply of rubber by serving as a solvent in reclaiming the material from old tires

other materials, and though our defense plans are far greater, we have a new protection against a crisis.

Our protection is our better understanding of chemistry, due to multiplication of research since, as a fruit of Allied victory in the last war, leadership in the largest chemical industries passed from Germany to the United States. In 1920, the total amount spent for chemical research in the nation was $25,000,000; today a single company spends $7,000,000 annually.

Early in the '30s a new phase developed in this research. Dr. William Jay Hale called it "chemurgy." Its plan was to take a new member, agriculture, into the partnership between science and industry. If certain products of the soil could be substituted for minerals in industry, and if certain others which had hitherto been used only for food could be worked into a variety of manufactures, then exhaustible mineral and oil deposits could be conserved and at the same time the farmer could be restored to his old economic independence. This sort of chemical "magic" was laughed at by some industrialists when it began, but much of it is commonplace today.

The most familiar examples of chemurgy are the use of casein derived from milk for plastics and artificial wool; the celebrated soybean oil and plastics; furfural for lubricants from oat hulls; ethyl alcohol from corn, barley, sweet potatoes, and Jerusalem artichokes to blend with gasoline for fuel.

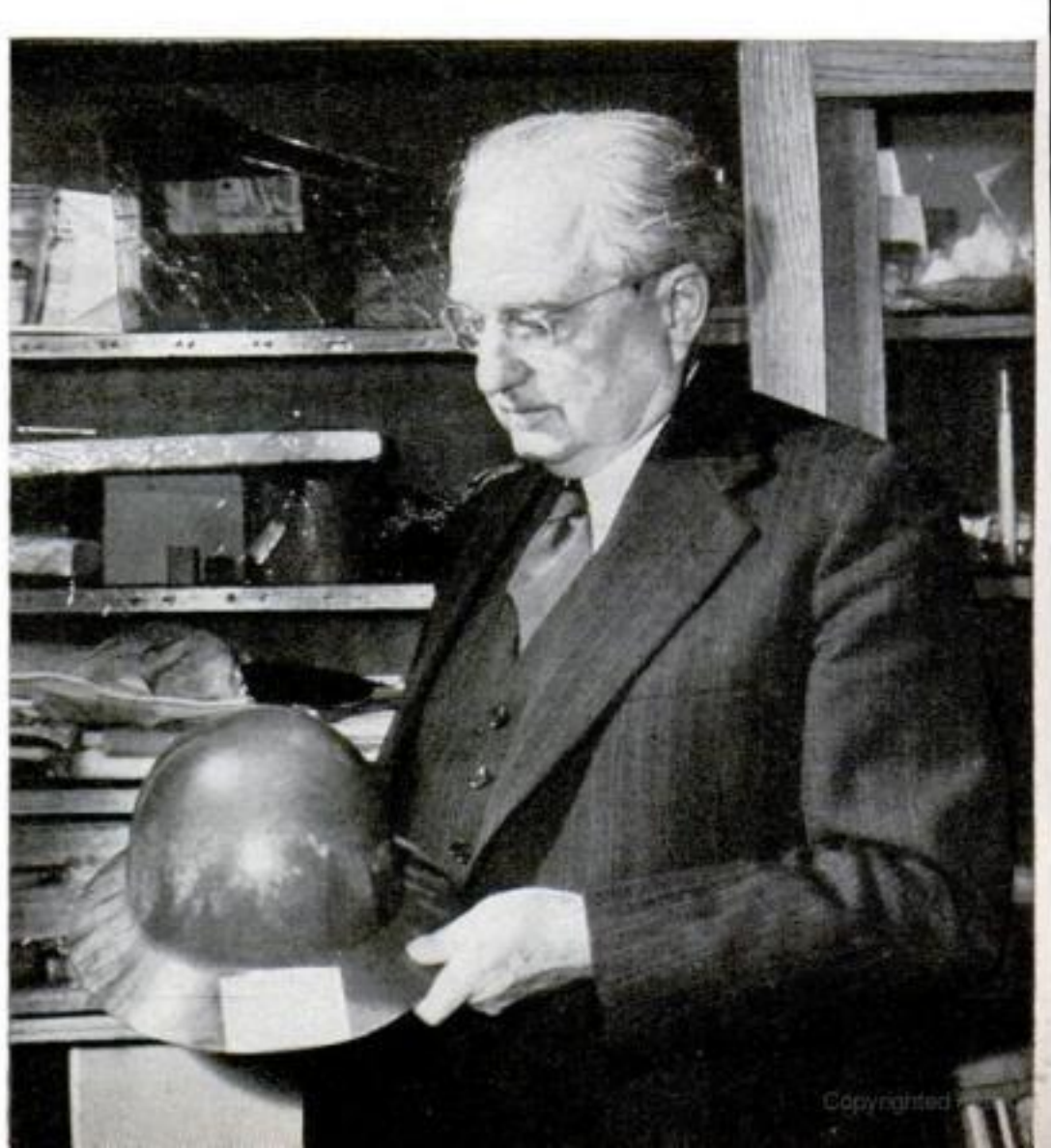
Since the first chemurgic conference at Dearborn in 1935, chemurgy has made long strides. Backed by the Chemical Foundation and its late president, Francis P. Garvan; by Henry Ford; by Louis J. Taber, Master of the Grange; and by the research departments of many large companies including Du Pont, it has found many research facilities. Today, the powerful National Farm Chemurgic Council, with branches in 28 states, includes among its governors professors, chemical and agricultural engineers, merchants, railroad presidents, editors, and public-relations men. Its scope has expanded to include forestry, water control, plant breeding, crop diversification, unemployment, and many other things besides the discovery of new uses for farm products. It maintains close relations with large and small farmers everywhere, giving them advice ranging from soil conservation to the painting of their barns.

Though the threat of war was remote from the minds of the conferees at Dearborn in 1935, it is evident from the reports of 1941 that almost every chemurgic step in the interval has been a help toward defense economy.

It was thought, for example, that the colossal defense demand for steel would stop automobile production. But now it appears that cellulose and protein plastics can be used for car bodies to replace steel sheet. Lately it has been announced that shortages in wool need not interfere with upholstery in new cars as a new artificial wool has been evolved from soybean protein which can be drawn into yarn after treatment with formaldehyde and sulphuric acid. Another report tells of a plastic tractor seat. Everyone has heard of the synthetic rubber from

A cow gave this hat. Prolon, a casein fiber made from milk, replaces imported fur commonly used in making felt, thus saving valuable ship cargo space

And this is a helmet of plastic made from cotton. The South's "surplus" crop can help provide metal substitutes, road binder, roofs for bomb shelters



coal and limestone, but this takes us back to the mines. A new report from one of the Government's recently built regional agricultural laboratories tells of experiments with synthetic rubber from corn.

A statement from the Office of Production Management in Washington suggests a possible aluminum shortage. But at the same time comes the report of success in two aircraft companies with molded wood plastics for wings, fuselage, and tails of planes. While it is not stated that these are fighter craft, it would be a great stabilizing step if war production in this industry need not limit normal production for commercial use. In any case, late advices from England report the extensive use of plastics as metal substitutes in military aircraft. One new British plane has 200 plastic parts.

The question of wood brings up a twofold chemurgic problem. Anyone watching the erection of the great new army cantonments must be aware of the quantity of lumber necessary. Even if the lumber is now available, is it not possible that the supply will be so reduced as to send prices skyrocketing for peacetime use later? Chemurgy has devoted much time to wood substitutes. Fiber boards made of such farm wastes as wheat straw are already taking the place of lumber as building materials. These straws and stalks would otherwise be destroyed. Now they can not only conserve our lumber but prevent flooding and erosion by keeping forested areas intact. One speaker at the Seventh Annual Chemurgic Conference in March of this year drew a picture of the day when "the farmer's home and perhaps other buildings will be made of plastics" produced from farm waste.

But the second part of the wood question involves the use of wood which is already wasted in lumbering operations. This includes sawdust, chips, and twigs containing cellulose and now widely used in plastics. It also includes the unsightly stumps which are left in the ground.

A story of the part stumps can play in national defense was told at the 1941 Chemurgic Conference by Paul Mayfield, a chemist for the Hercules Powder Company. In Georgia, Florida, and Mississippi there are billions of pine stumps in the cut-over lands of the long-leaf pine belt.

"These uneconomic remnants of the lumbering industry," said Mr. Mayfield, ". . . are storehouses of latent wealth in the raw, serving as the material for the production of wood naval stores, one of chemurgy's most important divisions."

The term "naval stores," he explained, means more than it meant in the days when the Phoenicians calked their ships and treated rope with rosin. Today rosin is used in linoleum, floor tile, soldering fluxes, electrical insulation, soap, paint, thermoplastics, matches, and many other things. Pine oil, another stump product, is used in textile processing, in the flotation process of mineral separation, and in the laundry. Still another, Vinsol resin, is used in cement and in asphalt emulsions for road surfacing. Truline binder is still another product which plays an important part in the making of foundry cores. All these and others such as special terpene hydrocarbons and alcohols, rosin esters—all aids to a variety of defense industries—can be got by the wholesome conversion of stump-filled fields into pasturage and land for reforestation. Figuratively speaking, this is a way of getting plowshares as a by-product of swords.

ANOTHER brand-new wood-waste product was announced at the 1941 conference. This is a processed charcoal said to be an effective substitute for coke. It can be used for blast-furnace fuel for production of high-grade iron, and also as a smokeless domestic fuel because of its relative freedom from ash and its lack of sulphur and phosphorus. Because there are an estimated 50,000,000 tons of wood waste—stumps, treetops, sawdust—in the northwest lumber country, this fuel might develop a steel industry on the Pacific coast.

Though we have gained immeasurably in chemical industries since the last war, other parts of our national balance sheets show heavy losses. Chemurgy has been deeply concerned in the disappearance of our cotton markets and the resulting surplus which has threatened so many southern planters with ruin. The problem has been complicated by the invention of the mechanical cotton-picker.

The use of cotton in plastics, film, explosives, rayon, and other things has helped. A great opportunity has come with the discovery that cotton fabric as a binder for bituminous roads considerably reduces construction costs and immeasurably decreases maintenance charges. While tar or asphalt cannot replace concrete for large main arteries, thousands of miles of cotton-bound secondary or "farm to market" roads can be opened through the south at a cost of under $4,000 a mile. Such a development would help a defense as well as a peace economy.

And lately, a New York engineer, E. C. Wallace, has made a suggestion for cotton which is more directly concerned with defense. He has shown that cotton is a better material than concrete for the roofs of bombproof shelters. A roof seven feet thick made of cotton bales will resist the penetration of a 6,000-pound bomb falling from 30,000 feet, whereas *(Continued on page 220)*

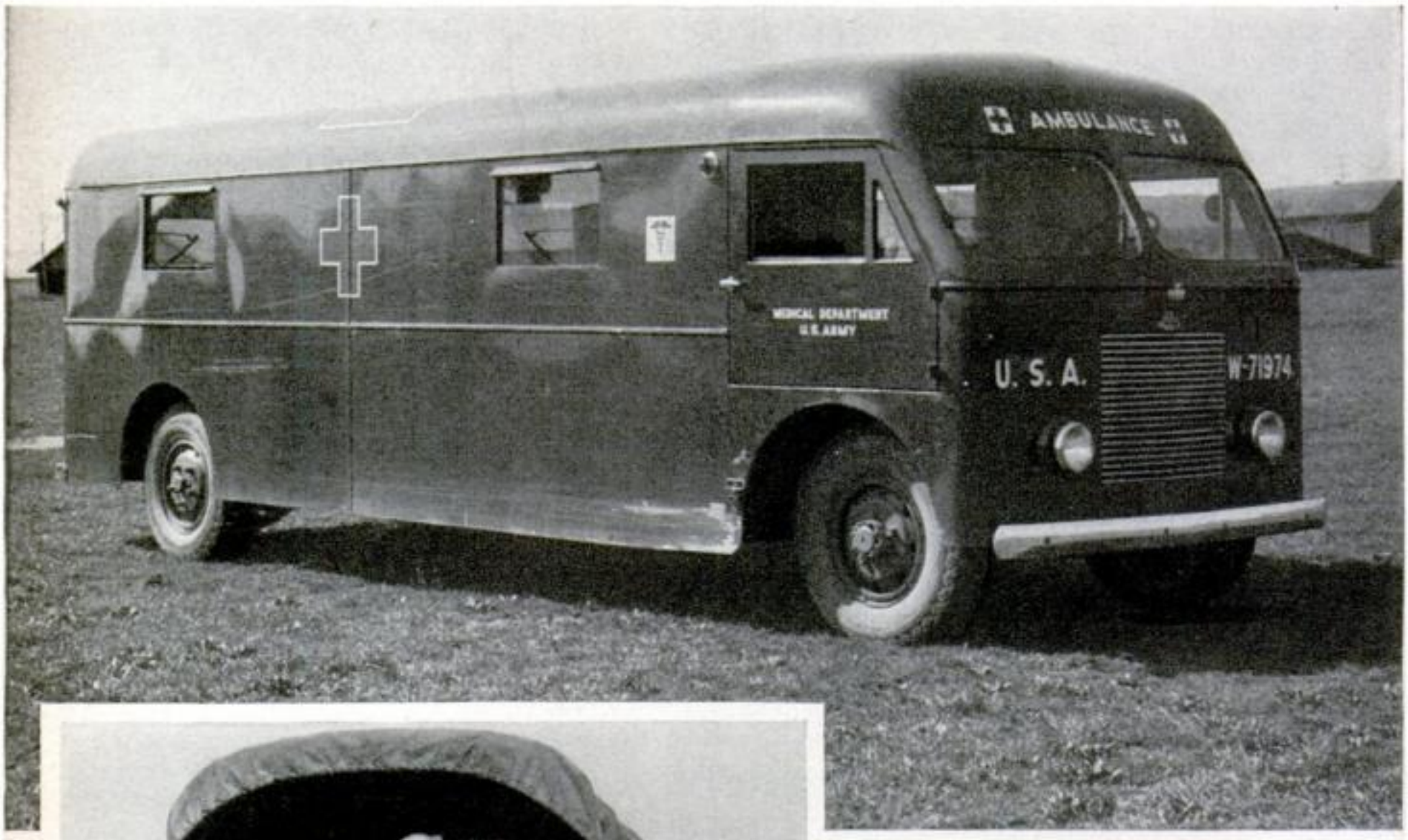
# Motorizing the Medical Corps

## KEEPS PACE WITH THE NEW ARMY

By JOHN WATSON

TO THE same all-out degree that American industry is supplying the sinews, bones, and blood to the nation's fighting strength, it is lending its technique and talents to the mechanical development of our Army's Medical Department which, under the urgency of modern warfare, has become a highly flexible and fast-moving branch of the military service. With equipment ranging from the new, compact mobile surgical hospital, which is moved in sections and can be set up directly behind a fighting front, to plastic splints for shattered bones, the Medical Corps, one of the several corps of the Medical Department, is making ready to keep pace with the swift and intricate processes of war as it is fought in the year 1941.

It was not so very long ago that badly




New bus-type ambulance being tested by the U. S. Army Medical Corps. It has front-wheel drive, with a 95-horsepower engine. Accommodates eight litter patients


Unloading medical supplies from a truck. Up-to-date mechanical aids enable this important branch of the Army to keep up with swiftly moving troops with its service of mercy

wounded soldiers, knowing that nothing could be done for them, prayed for death. As late as the seventeenth century, men were assigned to seek out the severely wounded and release them from their agony.

Today, by reason of the advances of science, medicine, and industry, together with the organization of the Medical Corps as an integral part of every fighting unit, a gravely wounded man has the almost certain knowledge that in a very little while help will come to him. Such knowledge sustains morale.

Each triangular infantry division in the Regular Army has a medical battalion, and each square division has a medical regiment. The medical battalions or regiments consist of collecting, ambulance, and clearing units.

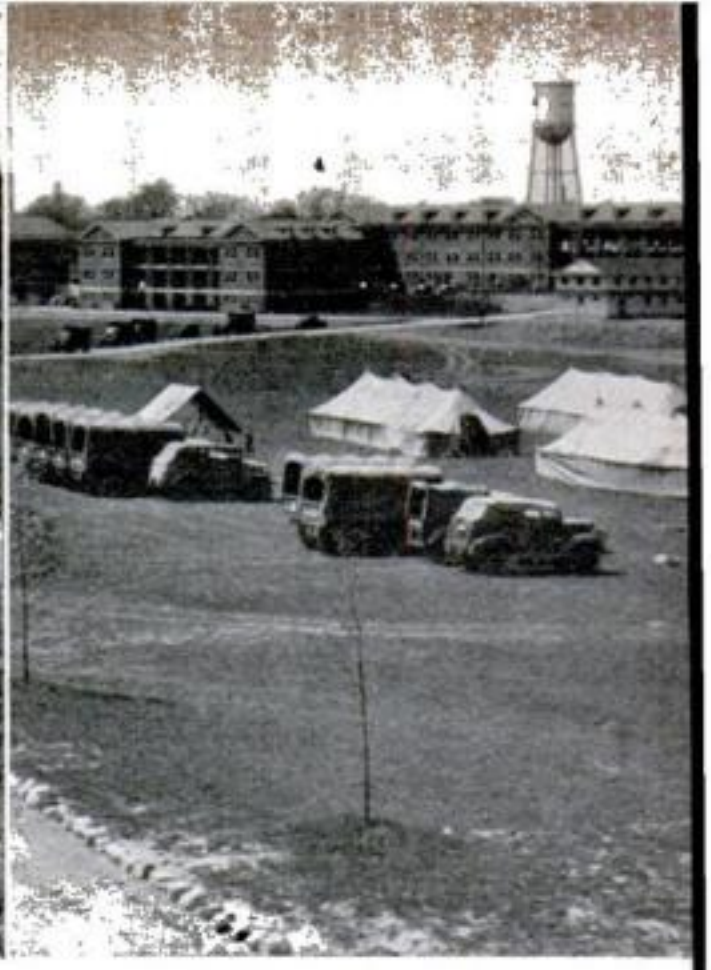
Each regiment and separate unit in the entire Army has a medical detachment. Each infantry battalion has a medical detachment of two medical officers and 27 enlisted men. Eight of these men are company "aid men," two attached to each company; ten are litter (stretcher) bearers, and the remainder are members of the battalion aid-station group. The medical officers and men move into a zone of action with the fighting troops.

Lest anyone think that being in the Medical Corps is a soft job, let him consider that the rate of mortality among medical officers in the World War was higher than

***Prompt, sure help reaches the wounded man on the field*** ➡

First to reach a wounded man are an aid man and litter bearers. Here they are showing how an Army leg splint is put on

The aid man's kit is a double-barreled pouch. In one pocket are ammonia, adhesive plaster, scissors, safety pins, iodine swabs, gauze bandages, forceps, blunt scissors, drug container, and a flask. The other pocket contains a pencil, small bandages, litter straps, and a book of tags for the injured and dead



***From the front-line area he is taken to a clearing station*** ➡

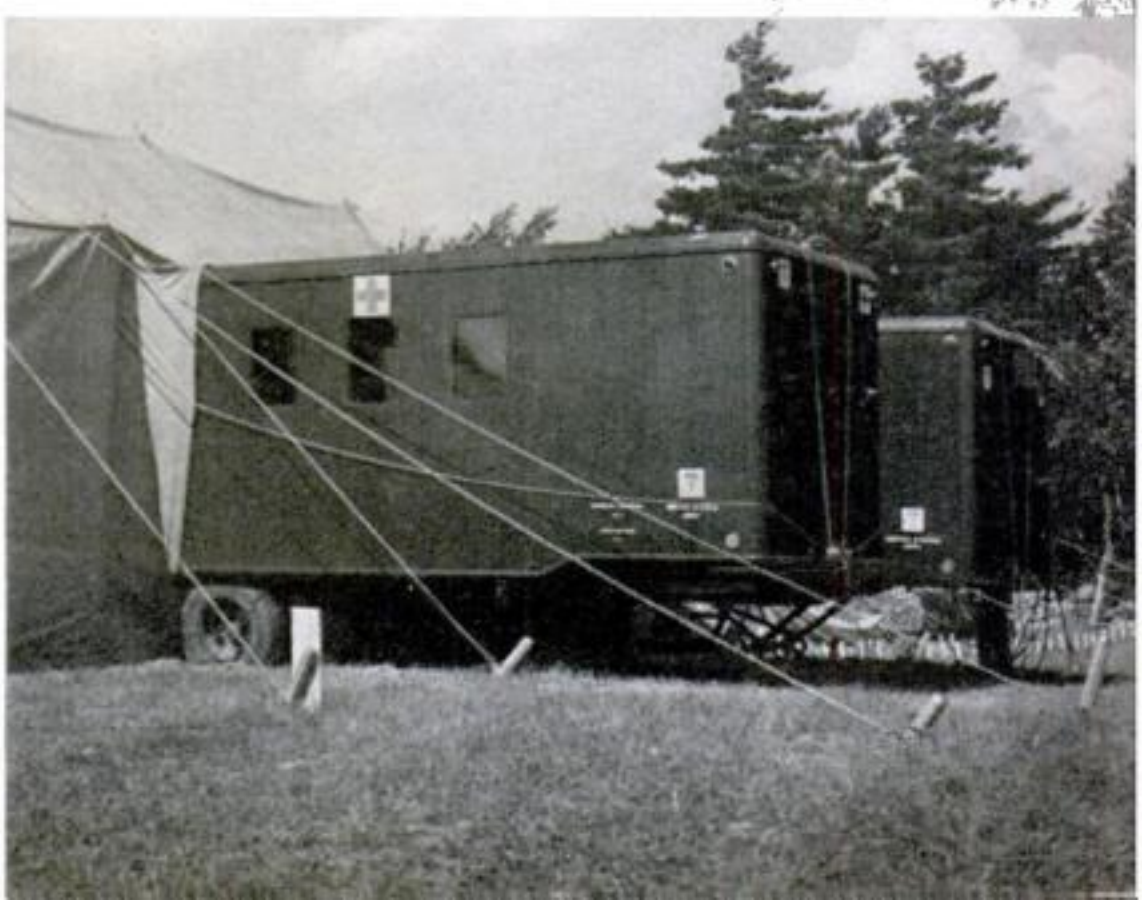
that for officers in the aviation, cavalry, engineers, ordnance, or quartermaster branches. It was exceeded only among officers in the infantry, signal corps, and artillery.

When a soldier is wounded on the field of battle, the first to reach him will be one of the aid men attached to his company. This aid man carries a kit consisting of an expandable canvas pouch. In the right-hand pocket of the kit are: 2 ounces of aromatic spirits of ammonia USP; 1 spool of 1-inch adhesive plaster; 1 bandage scissors; 2 cards of medium-size safety pins; 2 boxes of iodine swabs, 6 swabs to a box; 12 3-inch compressed gauze bandages; 3 triangular bandages; 1 enlisted men's instrument case, containing 1 hemostatic forceps and 1 pair of double-blunt scissors; 1 metal container for aspirin and other drugs; and one flask with a cup.

In the left-hand pocket are: 1 pencil; 8 packages of small first-aid bandages; 2 litter strap kits, for use with stretchers; 1 book of emergency medical tags, used to tag the wounded and dead. Before battle the aid men expand their pouches as far as possible and stuff them with extra bandages.

The aid man gives what help he can to the wounded fighter. Next, if he is unable to walk, the litter bearers move him to the battalion aid station, which is situated in

***For emergency surgery he goes to a mobile surgical hospital*** ➡



A "casualty" is registered at the recording station

After receiving attention in the field, he goes to clearing station

. . . which travels in trucks and is set up about five miles in the rear

If immediate surgery is required, he is rushed by ambulance (lower left) to the . . .

. . . mobile surgical hospital composed of six trailers backed into a tent

. . . as shown in the model below. The smaller tent holds cots for patients

Four trailers are operating rooms, one is an X-ray room, and one is a sterilizing room

***Here less serious cases***

the front-line area. Here he is examined and given prompt emergency treatment. From the aid station he is taken by litter or ambulance to the collecting station about a mile from the front line. Again he is examined, treated, and prepared for evacuation to the clearing station, about five miles from the front. Here minor cases are separated from serious ones. If the wounded man if suffering from a minor wound or from slight shell shock or gas poisoning,

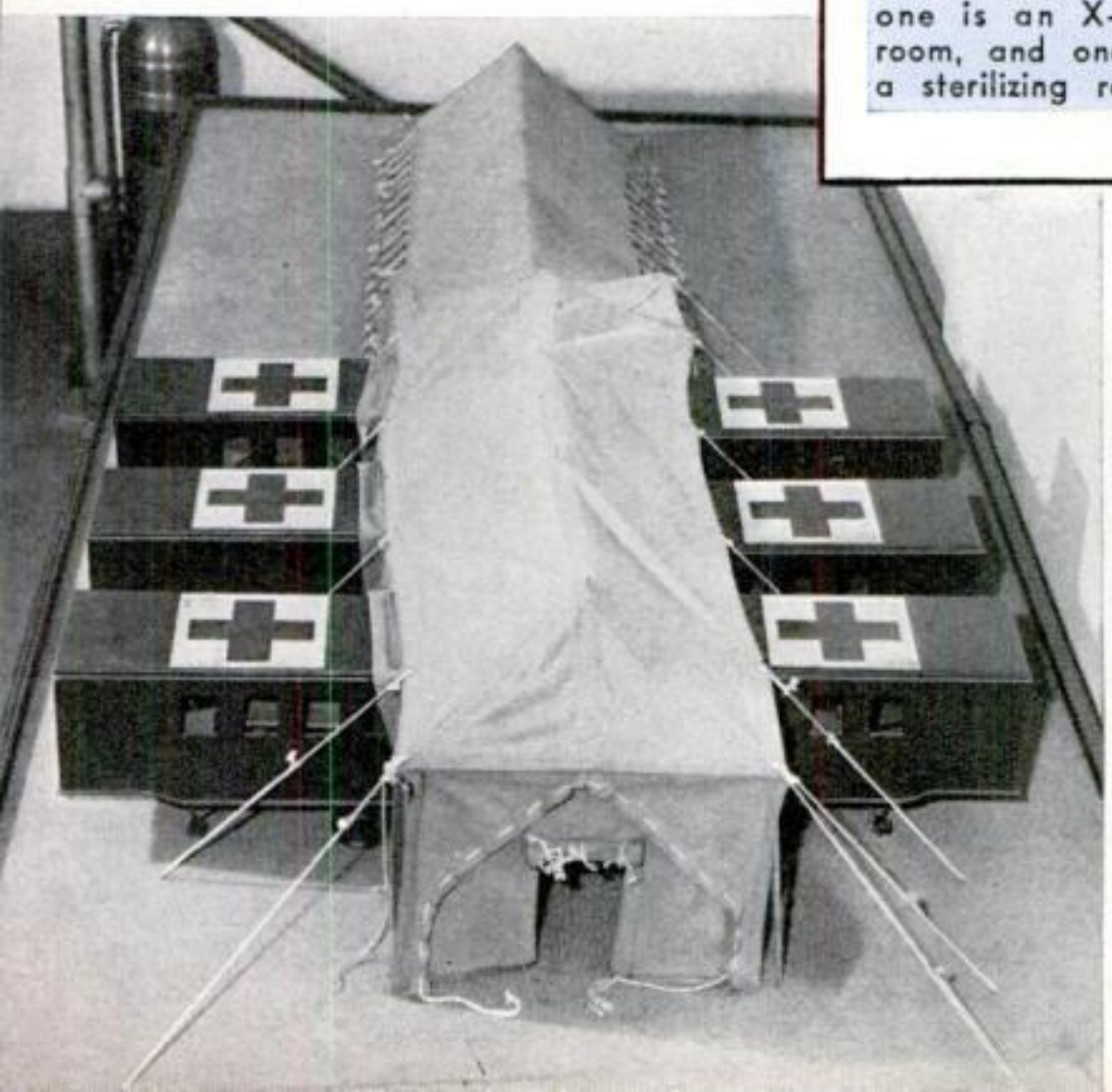
***are returned to duty*** ➡

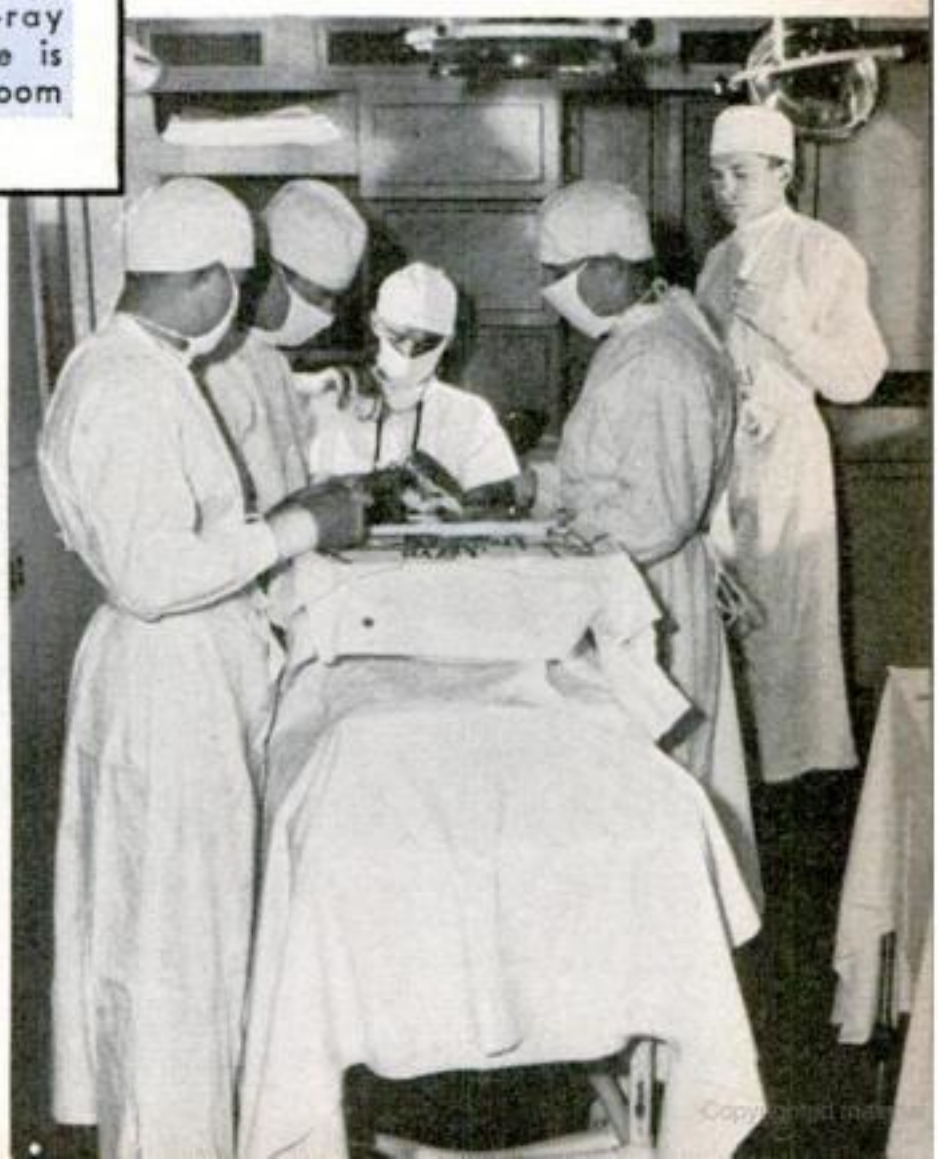
he is treated here and sent back to duty.

If the wounded soldier is injured seriously enough to require hospitalization, it is often possible at the clearing station to change him from a lying or litter patient to a sitting patient. A sitting patient takes up only about a third as much room in the ambulance as a litter patient. The new 1½-ton cross-country field ambulances, for example, have room for ten sitting patients but for only

***where trailer units form***

***the operating rooms*** ➡





four litter patients. The advantage is clear.

If the casualty is an immediate surgical case, he is rushed to the mobile surgical hospital which usually is set up in the vicinity of the clearing station. Or, if seriously wounded but not an emergency surgical case, he would be taken to an evacuation hospital equipped with all facilities for modern surgical and medical treatment. The final step would be to move him out of the combat zone to a general hospital.

At the Medical Field Service School, at Carlisle Barracks, Pa., tests are being conducted on two types of mobile surgical hospitals. The first type consists of units made up of semi-trailers, tractor-drawn.

Some of these trailers are made into operating rooms, some into X-ray rooms, supply rooms, sterilizing rooms. Others become moving laboratories, or power units to supply electric light and hot water and heated air, or to carry water tanks.

When the mobile surgical hospital is set up, a huge tent, divided into two sections, is erected. In the main part, known as the amphitheater, the operations take place.

Into the amphitheater tent are backed four trailer operating rooms, a trailer X-ray room, and a trailer sterilizing room. The rear doors are opened and the mobile surgical hospital is ready to function. Outside the tent are grouped two 2½-ton power-plant trailers, which supply electric current generated by gasoline engines; two 2½-ton cargo trucks or trailers, and a 2½-ton truck carrying a water tank.

The operating-room trailers are equipped for heat and ventilation and each one has three overhead operating lights, cabinets with special instruments, an anesthesia machine, and a 120-gallon water pressure tank.

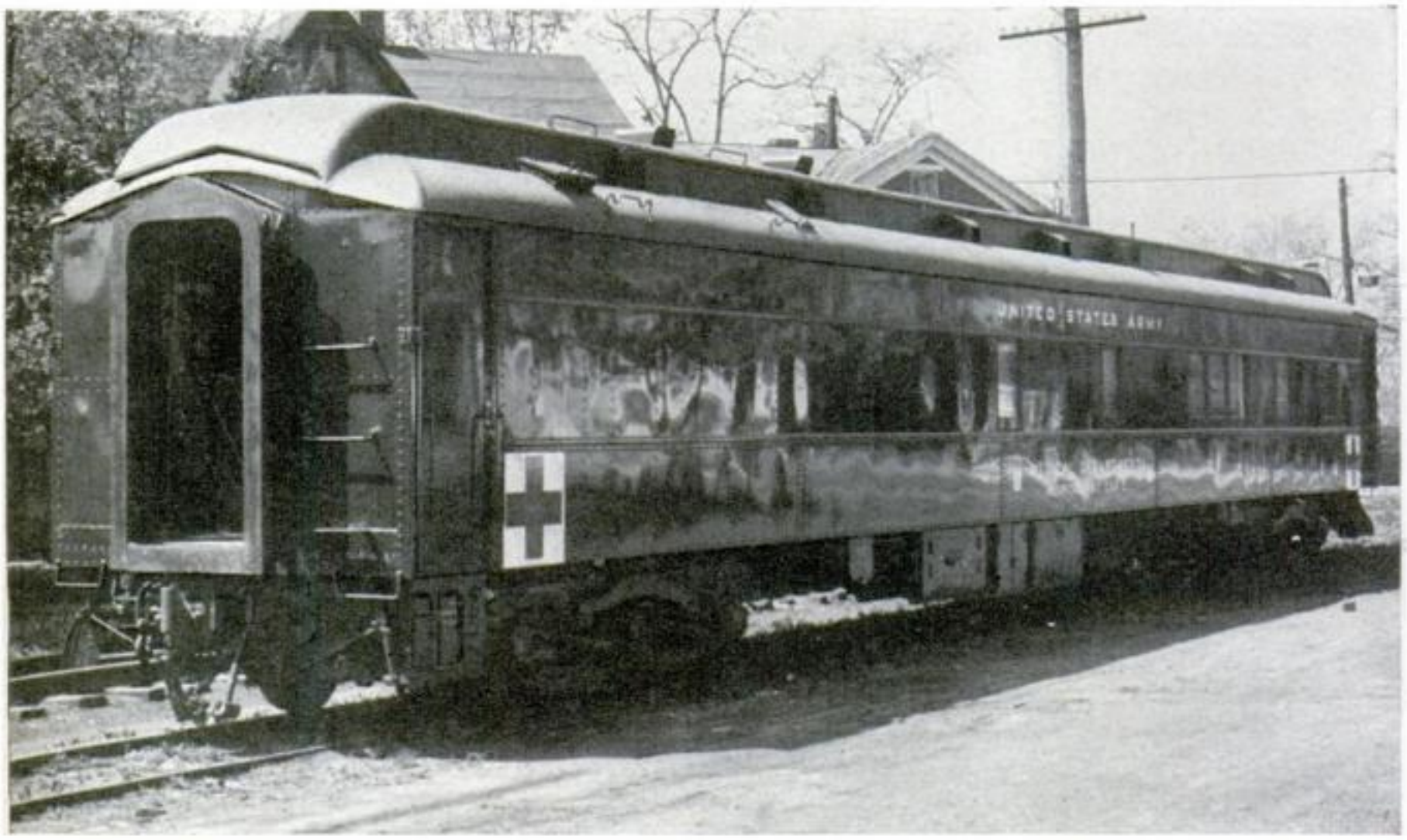
The hospital, it is conservatively estimated, can handle 80 major operations every 24 hours. In the rear tents 100 or more beds may be set up, where the patients are cared for until they can be moved.

The second type of mobile surgical hospital unit under consideration at the Carlisle Barracks is composed of busses, rather than semi-trailers. A bus-type ambulance, a 10,000-pound, front drive vehicle, is now undergoing tests. It can carry 20 sitting patients or 12 litter patients. The Medical Corps is considering turning some of these busses into operating, X-ray, and other units of the mobile hospital.

A new cross-country ambulance, made by Bantam, Dodge, and Ford, is called by officers the most efficient model ever developed. This is a four-wheel-drive, 1½-ton vehicle with high chassis and powerful springs.

Also under development is a hospital train consisting of reconditioned Pullman cars for transporting casualties to fixed hospitals in the rear. This train, according to present plans, is to be equipped with a heating unit, operating room, kitchen, sterilizing machines, and 3 tiers of bunks.

Airplane ambulances are being tested at the School of Aviation Medicine at Randolph Field, Tex. In the larger air ambulances there are emergency operating rooms.




Hospital trains of 10 or 15 cars include specially built units containing operating rooms and kitchens

# AUTOS

## Defense Has the Right of Way on Automotive Production Lines

# From Cook Stoves to Tanks

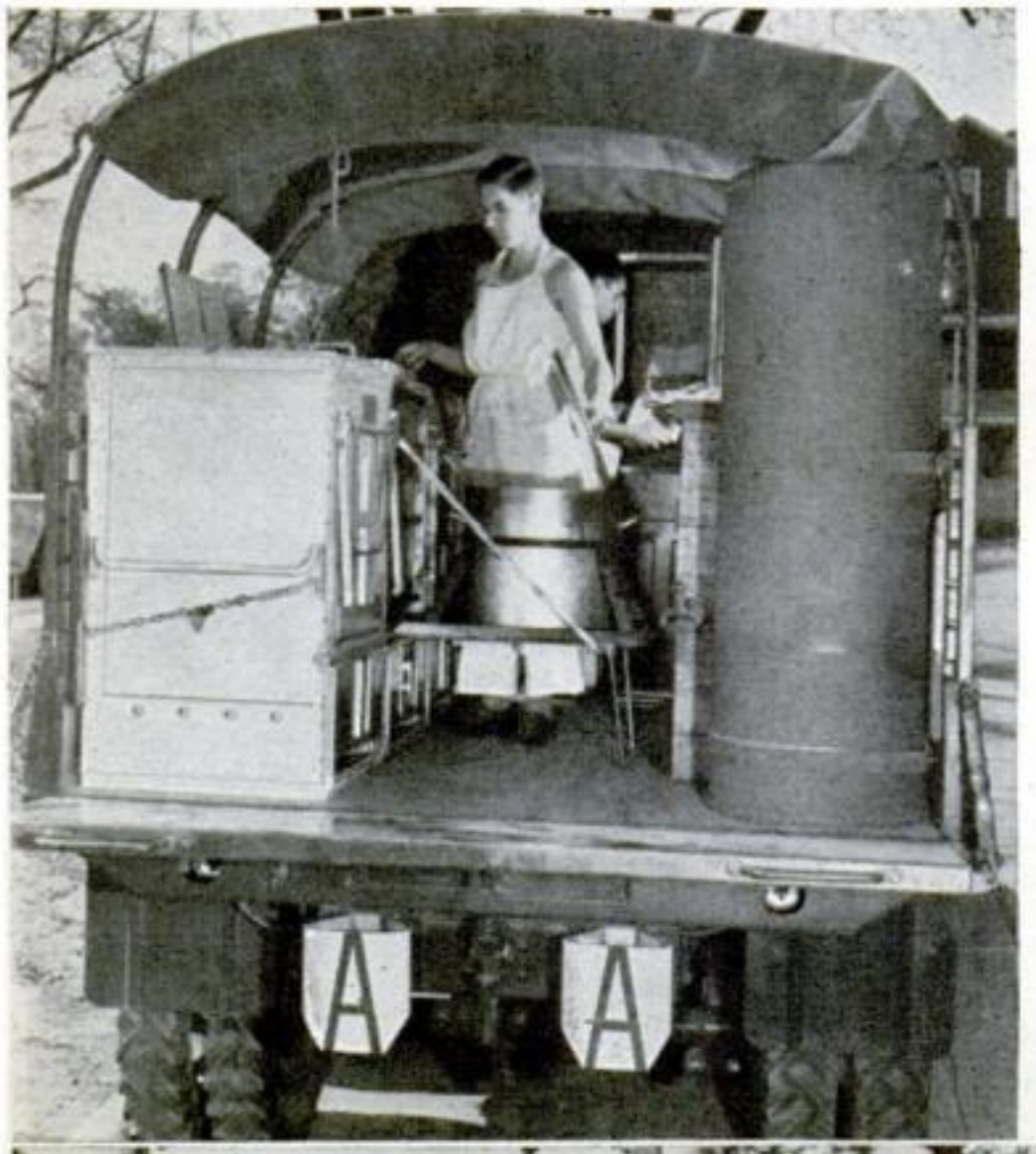
## . . . They Roll from the Automobile Factories

By SCHUYLER VAN DUYNE

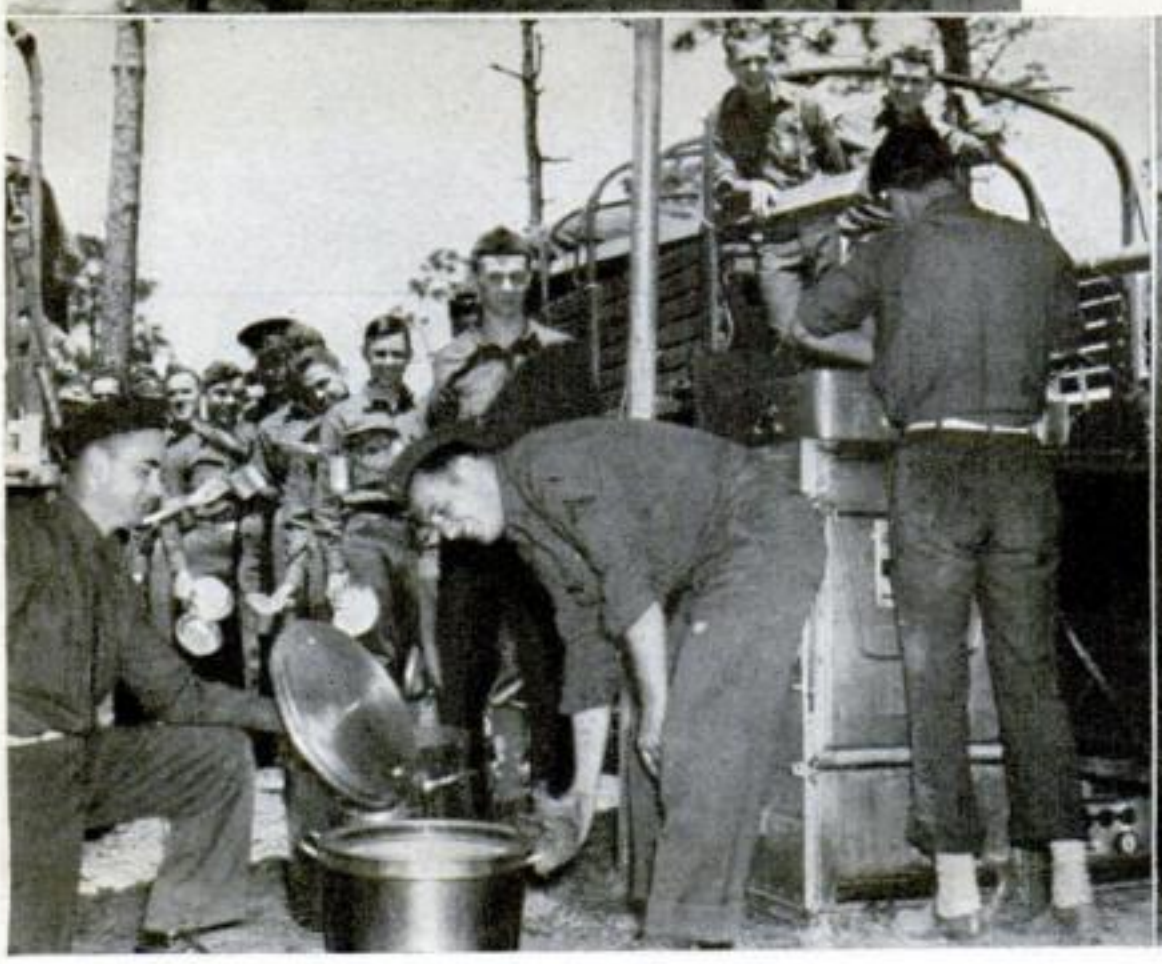
THE Detroit genius for industrial organization is sorting out the sudden chaotic avalanche of defense orders with its customary frantic and incredible orderliness. It is responding to the fabulous impetus of something like a billion and a half in armament orders assigned by the U.S. Government to the automobile industry.

The vast industrial center, already a huge magnet, drawing raw materials and manufactured parts selectively from many parts of the country, is being called upon suddenly for all its reserve power. Its standard products, such as automobiles, trucks, and their accessories, were in extraordinary demand, but now there are imperative pleas also for airplane, marine, and tank engines; for the airplanes and the tanks themselves and for antiaircraft guns, cook stoves, ammunition components, refrigerators, Diesel engines, and a conglomeration of other articles.

Mass production in all lines was the demand. It would seem to be enough to strike any group of industrial engineers dizzy. Dizziness is more or less a normal state, however, for an industry accustomed



ARMY COOK STOVES. Before a motor column finishes a day's run, these truck-mounted stoves start cooking evening mess



JOURNEY'S END, and chow is ready! It was stewed, baked, boiled as the motorized column sped along the highway

ASSEMBLY LINES, Detroit-style, produced thousands of these stoves—fast! Chrysler and Crosley take the credit

MONSTER AND MAW. As different from an automobile as a battleship from a canoe, the 28-ton M-3 medium tank is now an automobile-company product. To mass-produce it, Chrysler raised a sprawling arsenal, seen at top of page, in less than a year. By August, five tanks each eight hours will come off its three assembly lines. Other M-3 builders are: American, Baldwin, and Lima locomotive; Pressed-Steel and Pullman

to redesigning its major output every year, and the Detroit industrialists proved themselves tops. They turned out to be steadiest when spinning madly.

There were factories to be built whose individual dimensions are reckoned in fractions of a mile. The grandparents and the great-uncles of the machines which were to turn out the new products had to be found or manufactured in widely separated parts of the country, assembled and put to work so that their grandchildren and grandnephews and nieces would be ready for installation when the factories were completed. There were materials to be ordered in stated quantities for delivery at set dates so that the vast jig-saw puzzle would fall progressively into place and when the final rivet and the last nail was driven in Detroit, machines and materials would come marching into each building.

Between last summer and this summer fourteen acres of farmland sprouted the gigantic mushroom of the Chrysler tank arsenal, a vast structure of steel, glass, and brick which is a trifle more than a quarter of a mile from wall to wall. Atmospheric haze dulls the vision of the spectator seeking the details of the farther end.

Freight trains enter the building at one side and unload at the head of sub-assembly lines which stretch like the bars of a gridiron crossways of the plant. Huge grotesque machines with arms and angles reminiscent of Rube Goldberg or a non-objective painter stand in ranks beside the sub-assembly lines, which terminate in three assembly lines on the far side of the building where the tanks take form, five of them in each eight-hour shift.

Another spectacular achievement was the Ford defense plant, literally a hothouse growth. Work on it was started September 17, 1940. Detroit winters forbid masonry construction, but Detroit genius was not to be balked. An engineer who had encountered a similar difficulty on an assignment in northern Russia inclosed the entire job in a shelter of fiber board and tar paper and installed steam heat. Twelve hundred men worked three shifts a day in it and by April the first of 4,236 Pratt & Whitney twin-row, radial, air-cooled engines were coming off the assembly lines. Now the

MODERN MOTOR-CYCLE PLATOON. Indian and Harley-Davidson are filling defense orders to bring the Army's total of these vehicles to 27,000. The men shown here, ready for active duty, carry .45 caliber submachine guns that take the same ammunition as their .45 caliber Colt automatic pistols

LOW-SILHOUETTE CARS, can carry crews of three and machine guns. As reconnaissance cars, they are hard to see and hit. They're fast and powerful. Bantam, Ford, and Willys are building them

COMMAND CAR. This is one of Chrysler's nearly filled order for 58,000 Army vehicles. Tough jobs, command cars have six forward speeds and four-wheel drive. They hit 60, climb a 65-percent grade

STAFF CAR. Chevrolets, Fords, and Plymouths, these standard sedans, backbone of the civilian automobile industry, are providing dependable service in extensive behind-the-lines military transportation

AMBULANCE. This essential Army ambulance is being turned out in quantity for the Medical Corps by Dodge and Chevrolet. Fully equipped, it has ample power for negotiating the roughest terrain

SCOUT CAR. White and General Motors each hold car and truck orders approximating $100,000,000, of which a good portion is for vehicles of this type. They also are made by Diamond-T and Autocar

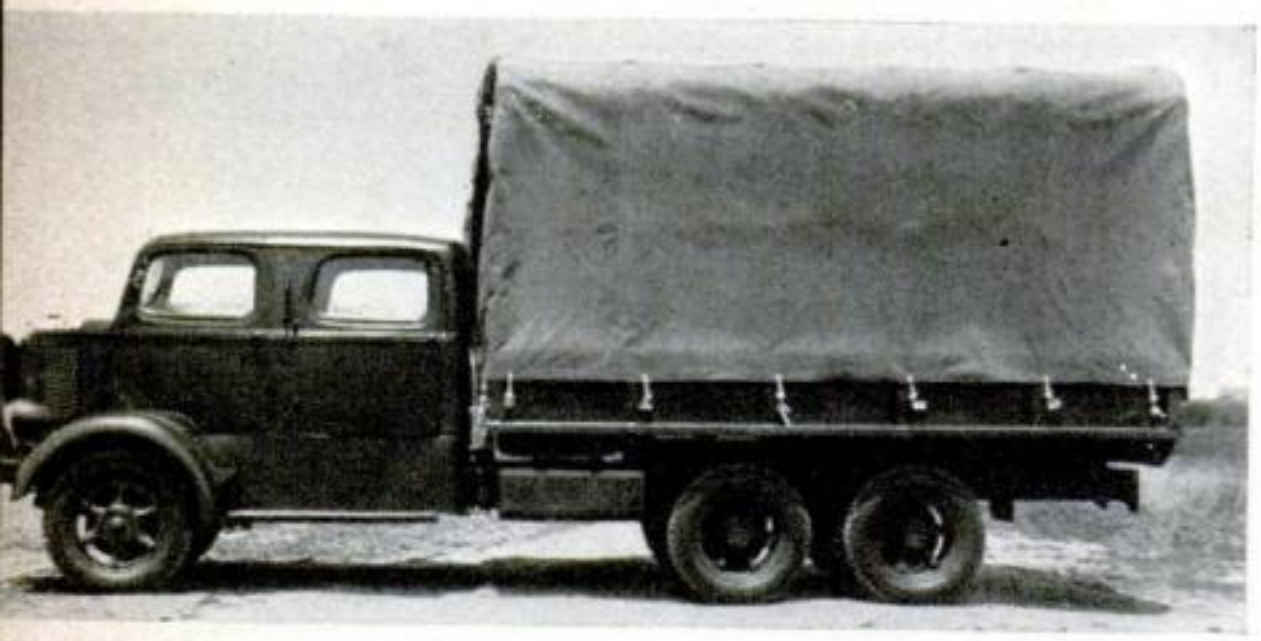
HALF-TRACK. Put an endless-tread drive on the scout car at left and you've got it. It patrols, tows artillery, carries radio, eight men, and three machine guns. The roller helps lift it across ditches

FOUR-BY-FOURS—the first figure refers to the number of wheels, the second to number of driving wheels. Shown are 1½-ton-capacity Chevrolet cargo or personnel trucks, ideal for cross-country

SIX-BY-SIX. You can't have a mobile motorized army without a mobile service station. This 2½-ton General Motors truck carries 750 gallons of fuel to supply road service for other military machines

ONE OF MANY DUTIES of the 1½-ton four-by-fours —loading equipment aboard a parachute-troop plane. Front wheels of new multiple-wheel-drive units are disengaged from the engine for normal driving, and, unlike the four-wheel-drive trucks of World War I, the vehicles are extremely easy to handle

PLANE SEARCHLIGHTS, sound detectors, and their crews are carried by six-by-four Mack trucks like the one shown. Note the odd design of the double cab which affords ample room for the driver as well as other personnel




SPECIAL-DUTY TRUCKS. A power-driven crane on the huge six-by-six truck at left easily hoists the power plant from an Army tractor for repairs to be made in the field, while the special Ford unit (below) for airport use speeds the loading of bombs aboard bombing planes. With a derrick and windlass, it can lift over half a ton

1,750 and 2,000-horsepower engines are taking to the air.

Similar miracles were wrought by Packard, Studebaker, Hudson, General Motors, and other industrial wizards. Minor miracles were being performed all over the country by the makers of machine tools whose powers had been invoked by Detroit. That industry had doubled in size in a year, constructing for its own use more machines than it had turned out in any of the years between 1931 and 1934.

The Detroit manufacturers always have been in the market for completed parts and knew the necessity of scheduling such orders in advance. Every year Buick buys 2,200 separate production items and General Motors has 20,000 industrial and supply firms on its list of submanufacturers. The purchasing and associated engineering staffs always have maintained the closest relations with these sources of supply and hundreds of their members were assigned at once to the job of stepping up and broadening production. They have kept to their schedule.

General Motors' Allison Division, currently making more than 400 12-cylinder, liquid-cooled, 1,000-horsepower plane motors a month in its defense-built Indianapolis plant, and anticipating 1,000 a month by December, put into effect a vast "farming-out" program to achieve this goal. Its purchasing agents distributed major

sub-orders to plants in 65 communities, which in turn buy from hundreds of other firms.

Studebaker, with a $33,600,000 order for Wright Cyclone 1,700-horsepower air-cooled radial engines, sublet 60 percent of the work to other firms, keeping 40 percent to be handled in its three new defense plants. Packard, almost ready to start production of 9,000 Rolls-Royce 1,000-horsepower plane engines—6,000 of them for England—in new buildings valued at $35,000,000, is depending upon 70 suppliers for parts and materials. Chrysler's tank arsenal will draw upon the products of 117 companies.

It is one of the basic wisdoms of Detroit's know-how. Even Ford, which boasts the closest thing to a self-contained industrial plant at its gigantic Rouge works, calls upon many outside parts suppliers and, like General Motors, buys from every state in the country. The British only recently adopted the idea with their "bits-and-pieces" program, but not before several too-highly centralized plants had been blasted by aerial bombs.

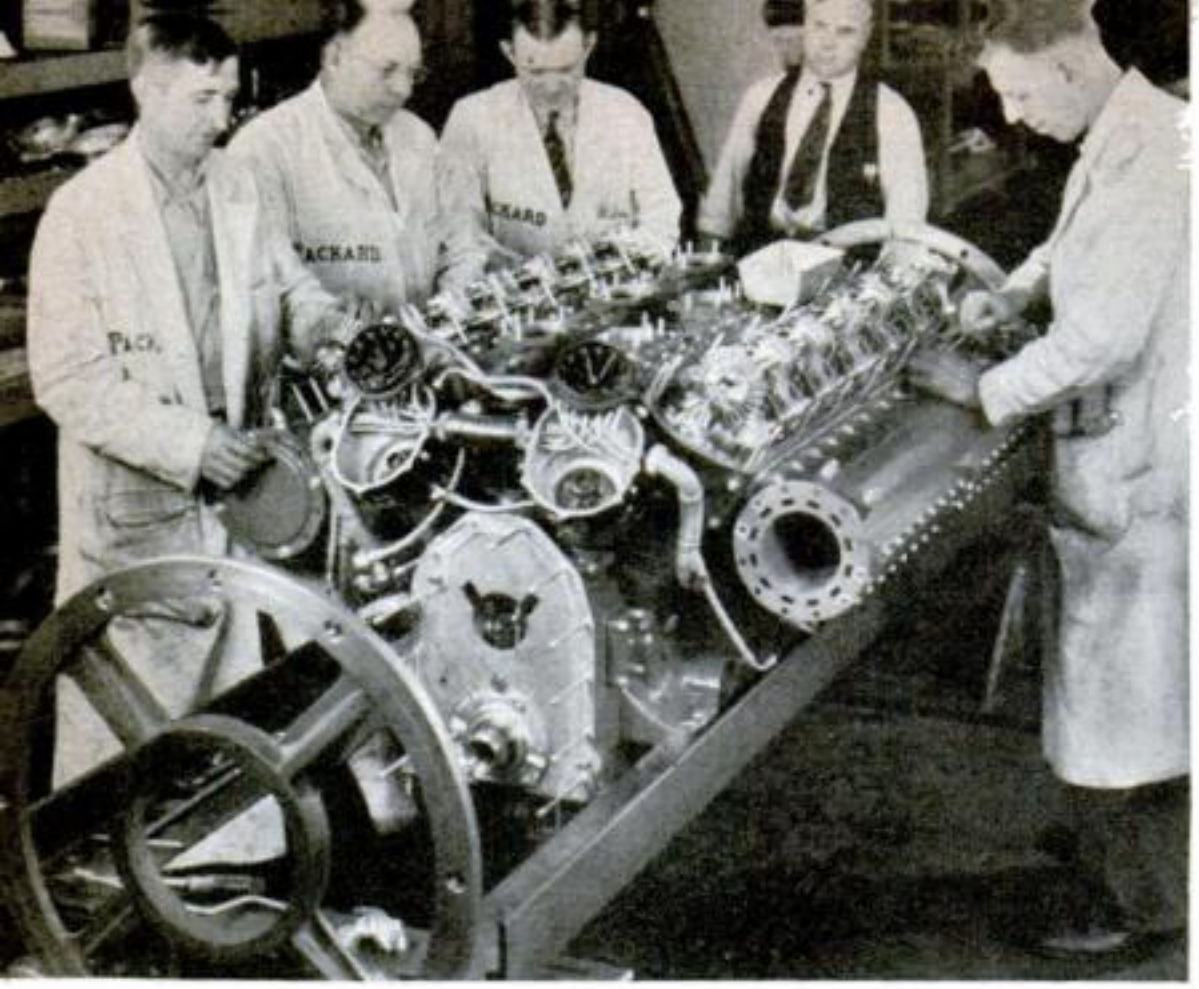
Germany was more provident. As early as 1937, sealed crates said to contain machinery for making toys after a few easy lessons were distributed to German farmers, who were told to store them for future use. With the invasion of Poland, Nazi officials appeared and ordered the crates unpacked. Out came drill presses, automatic screw-cutting machines, small drop forges, and similar machine tools with which the farmers, after their easy lessons, were soon making airplane fittings, bomb doors, and other parts for Messerschmitts and Heinkels and Junkers. That was farming out, Nazi style.

A recent estimate showed that the automobile companies have shouldered a total of $737,900,000 worth of plane-engine contracts for this country and Britain, nearly a fifth of all on order. Allison's order is for $234,000,000, Packard's for $217,000,000, Ford's for $122,000,000 and Buick's for $91,000,000 for the Pratt & Whitneys. Continental Motors' is for $40,000,000 for Wright 400-horsepower Whirlwinds converted for use in tanks, and Studebaker's for $33,600,000 for the Wright Cyclones. Any or all of these orders may be vastly increased before you read this.

Two major plane builders, Martin and Consolidated, placed their Government-selected bombers on display in an empty Detroit plant, where 1,400 manufacturers from

FIRST FORD PANZER PRAM, Edsel Ford at the wheel. His passenger is Brig. Gen. C. H. Bonesteel, who accepted it for the Army

REFLECTIONPROOF. These staff Fords are finished in dull olive paint, minus chrome plate, to prevent reflection by day or night. They also are equipped with blackout-type lights, front and rear



PACKARD MARINE ENGINES—1,350 horsepower, and three to a boat—power the Navy's and Britain's motor torpedo boats, driving them at speeds in excess of 60 knots

CHECKING DIESEL CRANKSHAFT, part of the G.M. $140,000,000 order for Navy propulsion machinery. Diesels power submarines, tankers, tugs, and other Navy vessels

all over the country studied them. Most reported that they could supply some of the parts.

As a result, Chrysler was given orders for the two forward sections of the twin-engine Martin B-26 fuselage, which it is building in the Graham-Paige plant. Hudson is making the rear section and small parts. Goodyear, pending plant construction, is making the wings in its gigantic "air dock" at Akron, where a special ceiling had to be built to prevent condensed moisture from "raining" on the work.

General Motors' Fisher Body Company is expanding its Memphis, Tenn., plant for construction of the North American-designed B-25 bomber, a type similar to the Martin. Ford is rushing an $11,000,000 factory near Ypsilanti, Mich., for complete four-motor Consolidated B-24 bomber airframes.

Detroit reaches down into its bag of tricks and comes up with new wonders like the Allison aircraft and Packard marine engines. Another engine tapped for defense duty and as adaptable is the product of the Cleveland Diesel Engine Division of General Motors. Actually, it is not so much an engine as it is two cylinders. One is comparatively small, with only 71 cubic inches displacement. The other is large—567 cubic inches. Just these two are made by the company. Yet they are the power packages for engines ranging in horsepower from 15 up to 1,600, and they can power anything from portable lighting plants to the biggest submarines.

MACHINE-GUN BARRELS in the raw at one of four G. M. plants filling a $61,000,000 order for the much-needed guns

Inspecting the barrels after machining (opposite page). Two types of machine guns are being made: .50 and .30

. . . air-cooled Brownings, some of which are shown at far right. They were completed far ahead of schedule

Uncle Sam has ordered Diesels using these cylinders to the tune of $140,000,000, principally for the Navy. The engines are about one quarter the size and weight of the Diesels that powered American submarines in the First World War. They more than double the cruising range of the earlier submarines, and their weight, space, and fuel economies step up the value of Navy tugs, patrol boats, fuel transports, and other vessels. Many believe that these amazing two-cycle, relatively high-speed Diesels—installed in large numbers in a single hull—will power a radical new American battleship.

Some 13,000 military vehicles a month are being built by the automobile industry, with 195,000 already delivered and 60,000 others scheduled for early delivery.

In addition to 5,900 passenger cars and 27,000 motor cycles, the vehicles ordered are 4,500 quarter-ton scout cars from Ford, Bantam, and Willys; 69,000 half-ton pick-up and reconnaissance trucks from White; six-ton and heavier units, from Autocar, Biederman, Chevrolet, Corbitt, Diamond-T, Dodge, Federal, G.M.C., International-Harvester, Mack, Marmon-Herrington, Reo, Sterling, and Walters. Practically all military trucks are four-wheel drive, many are six, and others are half-track. The total does not include 37,800 trailers for 2½-ton trucks, being built by Nash.

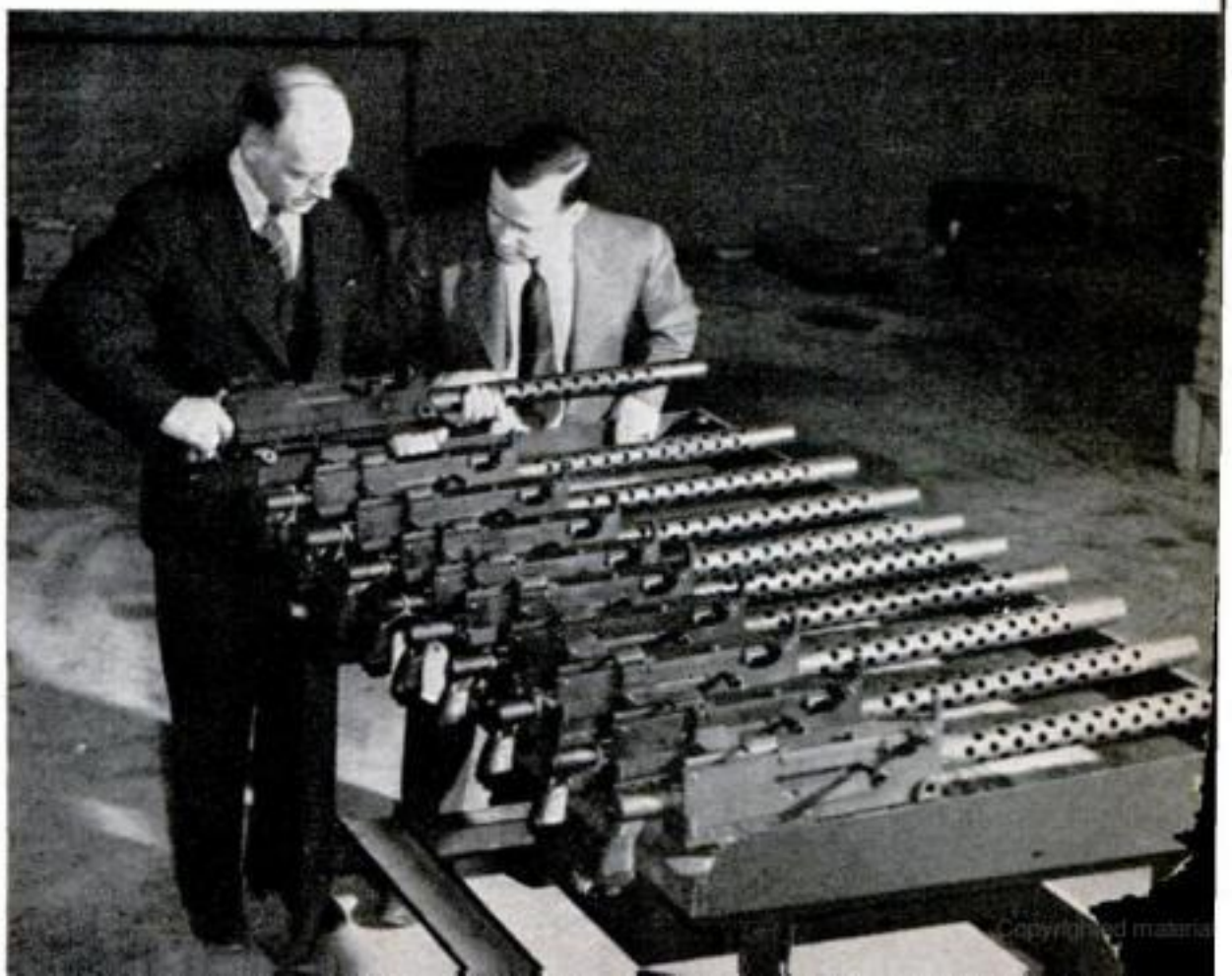
And the defense articles of Detroit stretch on and on: gun and torpedo parts for the Navy, bomb and shell components, field kitchens, field range cabinets, antiaircraft fire-control apparatus, instruments, aviation spark plugs, radio parts. For many of these, the industry's parts and equipment makers account. Typical are the Briggs, Fisher, and Murray car-body builders, the huge wheel and brake-drum makers such as Kelsey-Hayes Wheel, Budd Wheel, and Motor Wheel, and the Bendix Products Division of Bendix Aviation.

The War Department is watching with an eye to the future the Detroit research laboratories. Most startling appears to be the simultaneous development in each of the Big Three laboratories of new airplane engines to develop from 1,500 to 2,400 horsepower. All three projected engines are liquid-cooled, in-line types. Ford's is a 12-cylinder, V-type power plant with an exhaust-driven supercharger, and fuel injectors instead of carburetors. In construction, the cylinder liners, crankshaft, and other major parts will be made by a new "centrifugal-casting" method which is claimed to be faster, cheaper, and to produce stronger parts than conventional forging and machining methods now employed.

Chrysler and General Motors are more secretive. Reports are current, however, that Chrysler's engine will make better mechanical use of extremely high-octane fuel than any engine yet devised. The G.M. design is a conversion of the Allison, using four banks of cylinders arranged in a W instead of two in a V as at present.

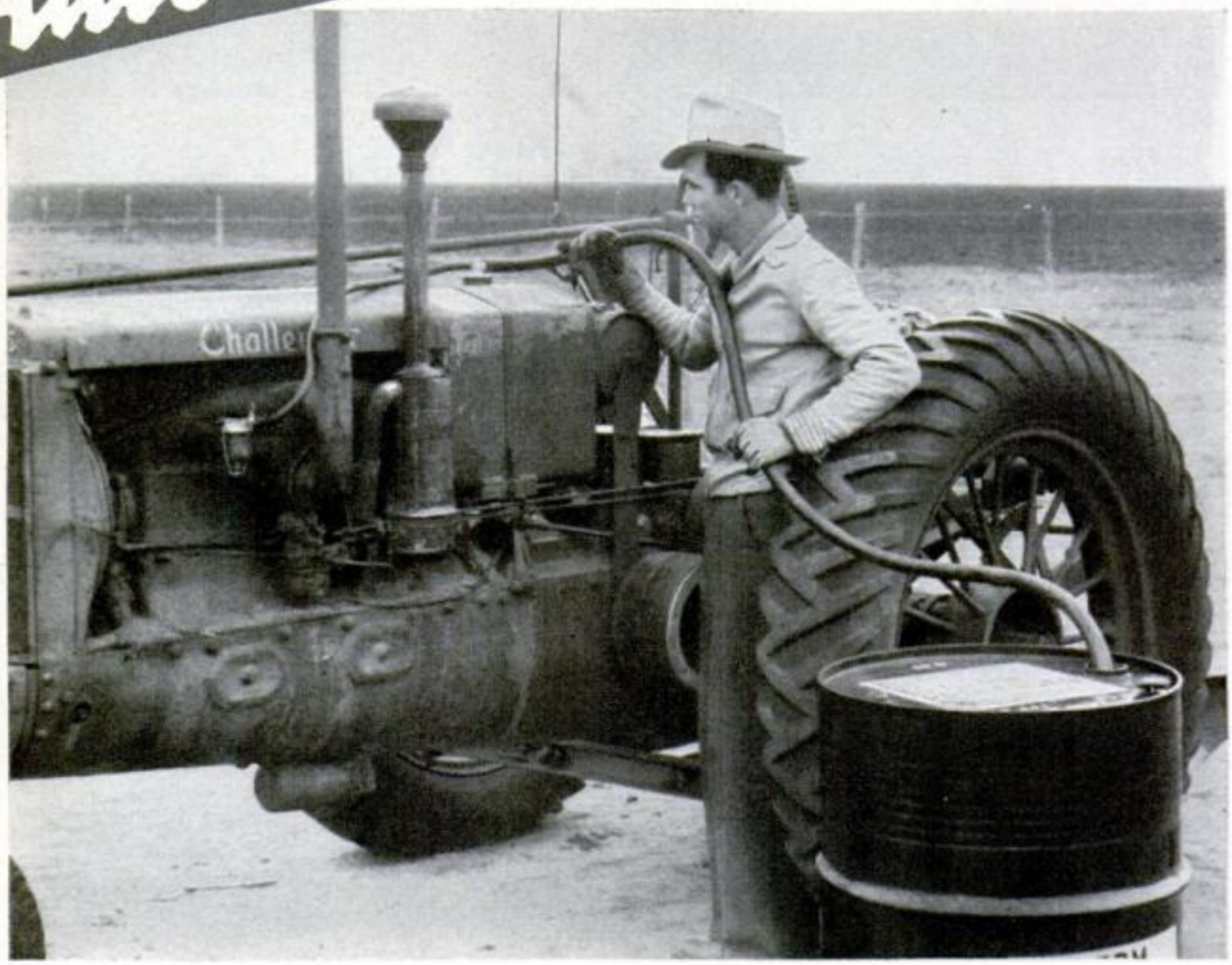
Engineers in one General Motors plant designed a multiple drill that bores out six machine-gun barrels at once—a feat not even the old-line gun makers had accomplished. A Chrysler research group designed a new plane landing gear which could be built faster than present types.

The list of defense orders placed with the industry looks like a dozen pages from your telephone book, and the cost figures mean about as much. Because new contracts are coming in so fast, totaling their value is next to impossible. Some recent official figures out of Washington put the industry's defense contracts at $1,076,082,000, but it is estimated that they are by now above the billion-and-a-half mark, with no end in sight. That's a lot of money to pay even for Detroit's know-how. Yet no one has complained but Detroit, where the only thing they'd rather do is build new and better automobiles.



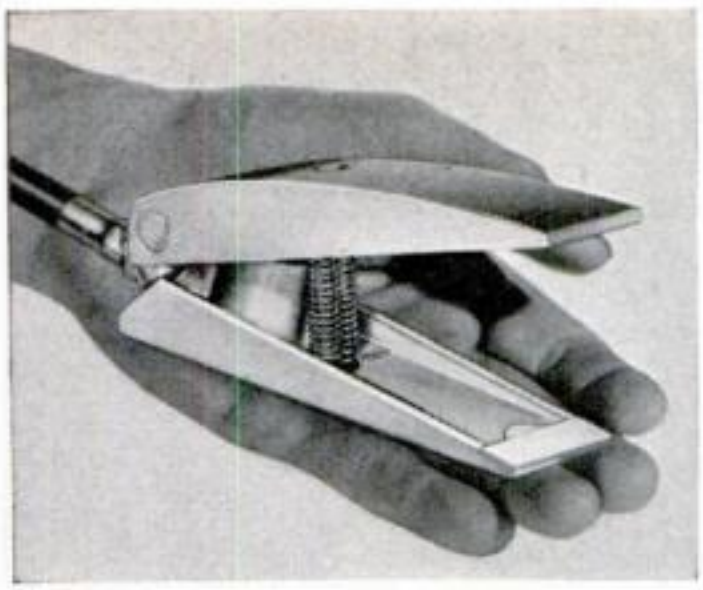
# Auto Ideas

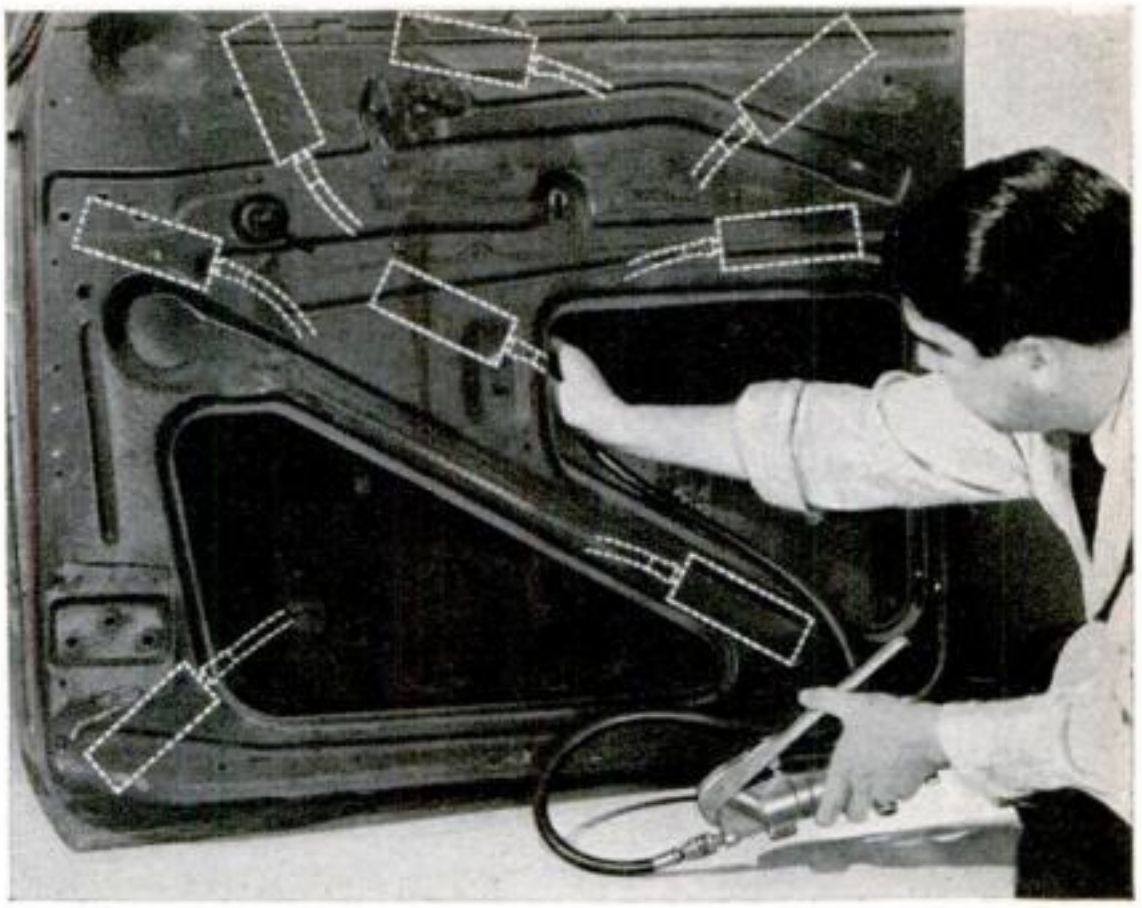
"Fill 'er up," cafeteria style: This tractor is using its own intake-manifold vacuum to suck gasoline into its tank from the drum




**ENGINE PUMPS OWN FUEL.** Tapping the vacuum of a gasoline engine's intake manifold through a convenient fitting or opening, a new fuel "pump" quickly fills the fuel tank of a car, tractor, or other vehicle. In use, the pump is placed in the opening of the tank, and the engine started. Fuel is drawn from storage through a flexible hose into the vehicle's tank. When the tank is full, an automatic shut-off prevents overfilling.

**CLEANING AND DECARBONIZING** pistons, carburetors, Diesel injectors and pumps, and other engine parts is simplified by a new chemical compound. Parts to be decarbonized are placed on a wire-mesh tray and doused in a tank containing the fluid. The tray is lifted out and placed in a rinsing solution to complete the operation. The maker points out that the compound is useful for decarbonizing antiaircraft and machine-gun mechanisms in the field while an army is on the move.





Connected to a hand pump by means of a flexible hose, the jaw-like jack unit at upper left can be moved about inside a door

**CAR-DOOR DENTS ARE EASILY FORCED OUT** by means of a new hydraulic hand jack of narrow design. Consisting of a jawlike unit which can be inserted inside a door between the stamped steel frame and the outer panel, it is connected to its hydraulic pump by means of a length of flexible hose. The jaws of the jack open with great force when the hand pump is operated, and the jack may be moved about so that the controllable pressure of the jaws is exerted where needed. A coil spring closes the jaws for removal when pressure from the pump is released.

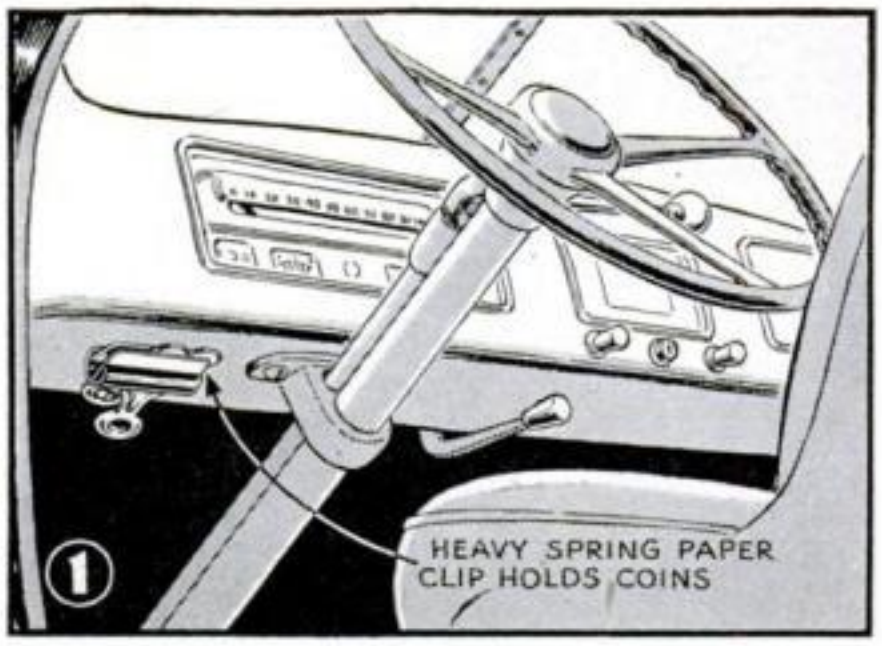
**TWENTY-FIVE THOUSAND PIECES OF DECORATIVE PLASTIC TRIM,** moldings, and other car parts can be turned out daily at the plastics plant operated by the Chrysler Sales Division to supply Chrysler-made cars. All interior plastic decorations are made of Tenite, which is supplied to the plant in granular form, and which is produced from cotton and wood. After coloring, the material is formed in "injection-molding machines," which heat and melt the material, then press it between dies at pressures reaching 50,000 pounds to the square inch. Because the steel dies possess mirror-smooth surfaces, the parts themselves come out with a finish that requires no additional smoothing. The longest piece ever molded in an injector press is produced daily in quantities at the plant. This is a 32-inch door garnish molding for a club coupe.

Poorly furnished rest rooms won't annoy you if you have one of these kits along. As shown at right, it contains a washcloth, towel, and powdered soap

**HANDY FOR AUTO TRIPS,** a kit containing a washcloth, towel, and soap powder, each item in a separate compartment, is designed to be carried in a dashboard glove compartment. Intended for use on trips where well-equipped rest rooms are scarce, the inexpensive kit has an attractive cloth exterior, while the inside is lined with waterproof artificial rubber.

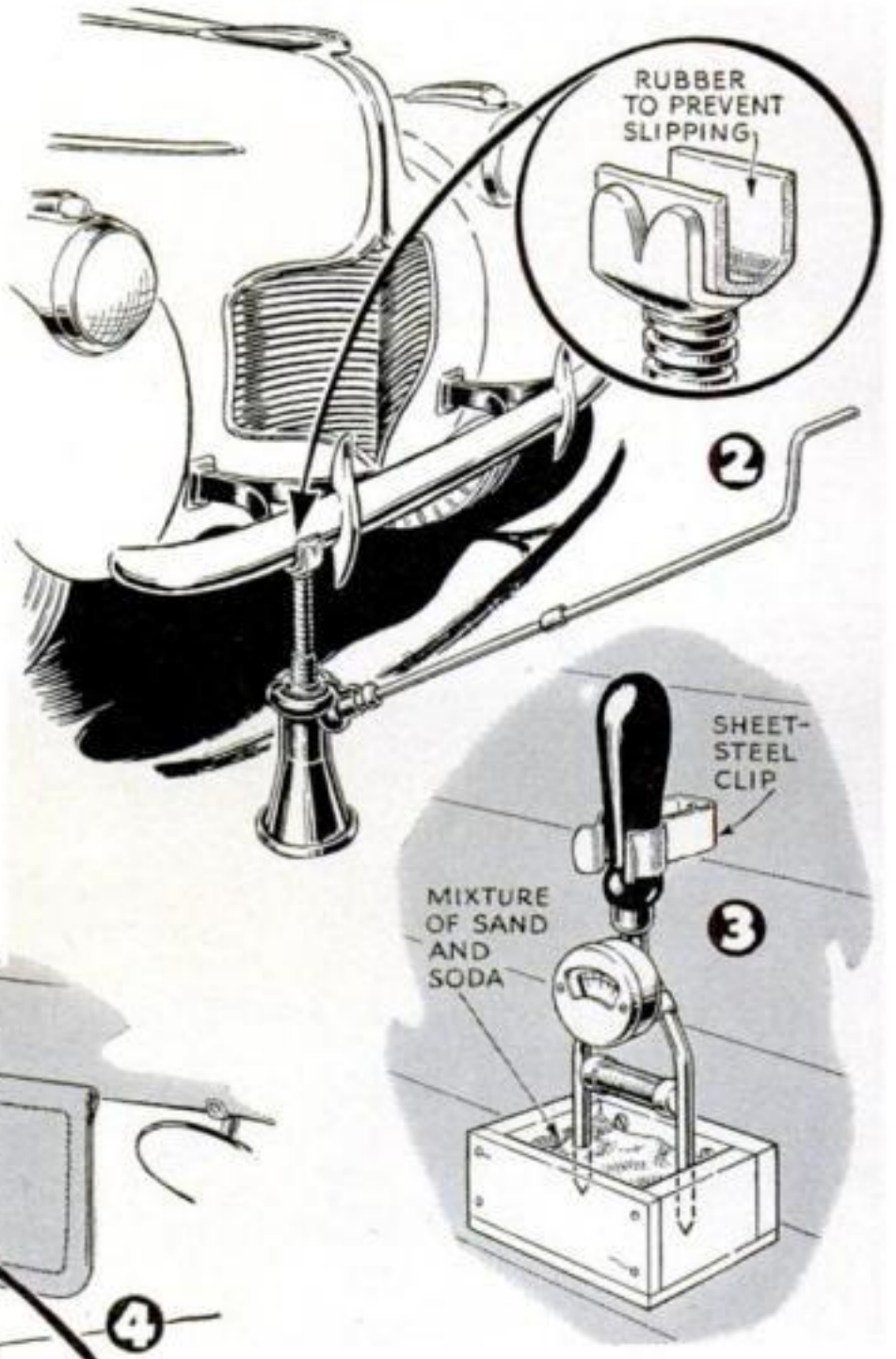
# EIGHT HANDY IDEAS

**1 COINS FOR TOLLS** on highways, bridges, ferries, and tunnels are always at your finger tips in this special holder mounted on your dash. A heavy spring paper clip is attached to the dash with a screw through one of the handles. Coins pinched between its jaws are easily removed as needed.—D.K.

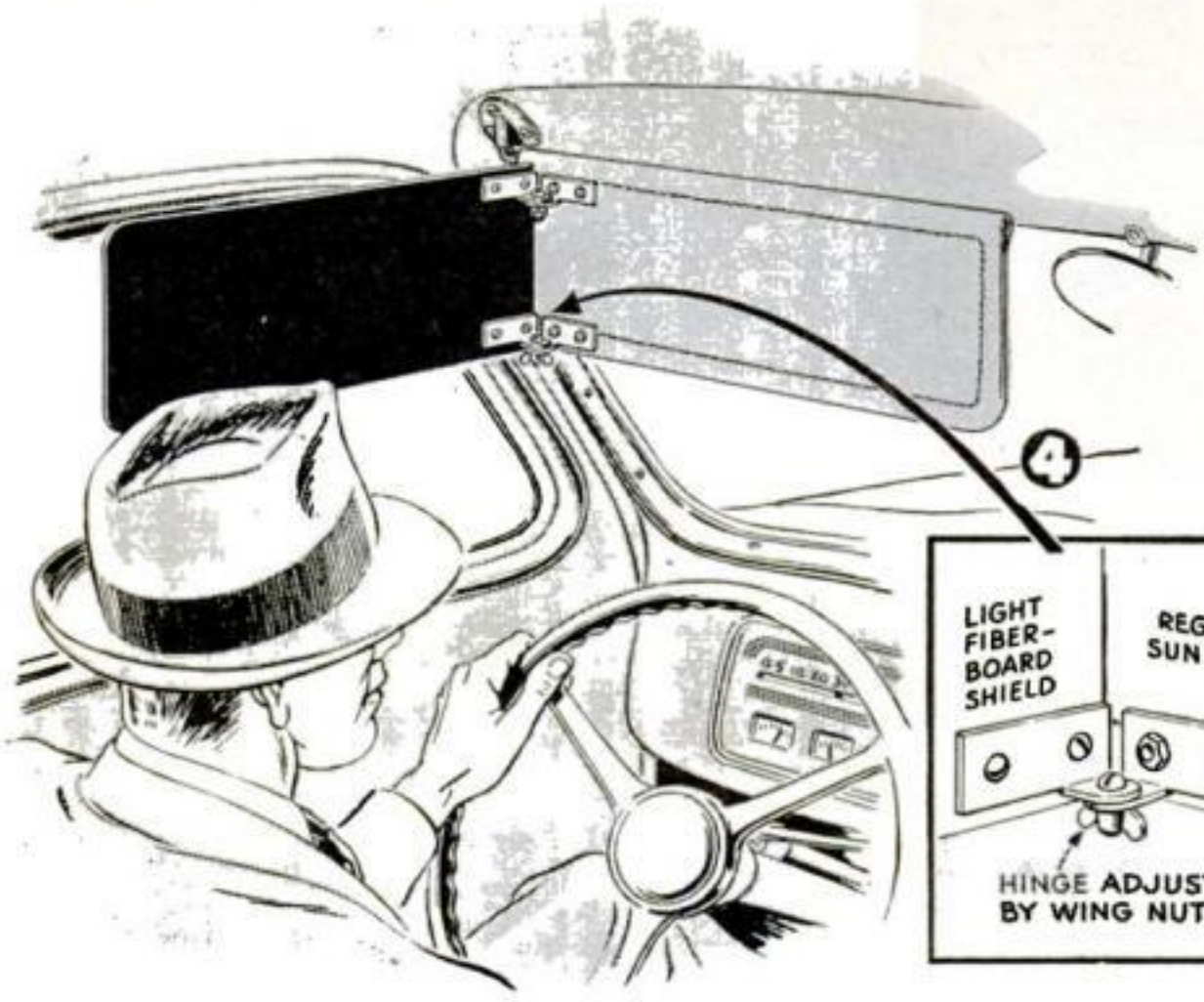


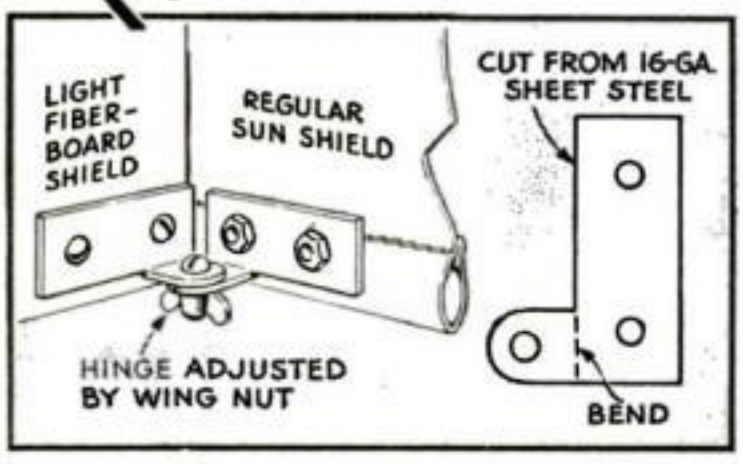

**2 SLIP-PROOFING A BUMPER JACK** is easy if you keep on hand a few pieces of old inner-tube rubber about one by two inches. One of these folded in the notch of the jack will keep the bumper from slipping. I always carry a few of the rubber pieces strung on a wire in my trunk compartment.—M.J.P.

**3 BATTERY-TESTER PRONG POINTS** often become corroded and dulled through neglect when not in use. To prevent this, attach a clip to the wall to grip the handle of the tester, and beneath it mount a small trough. The latter is filled with a mixture of sand and soda which keeps the tester points bright and sharp.—W.G.W.

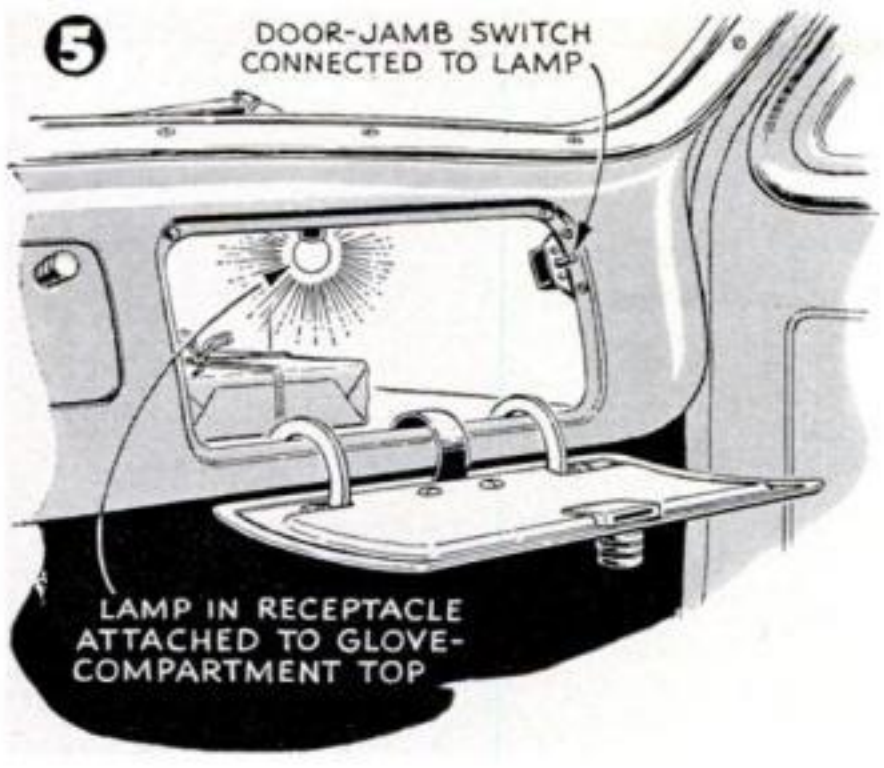



**4 TWO-IN-ONE GLARE SHIELD.** While traveling against the sun on a winding road, you are likely to find yourself continually shifting the glare shield back and forth between the windshield and the door. Hinge an extra shield to the front shield as illustrated. When not in use, it folds against the front shield, which swings up against the top in the usual manner.—E.H.



# FOR THE MOTORIST



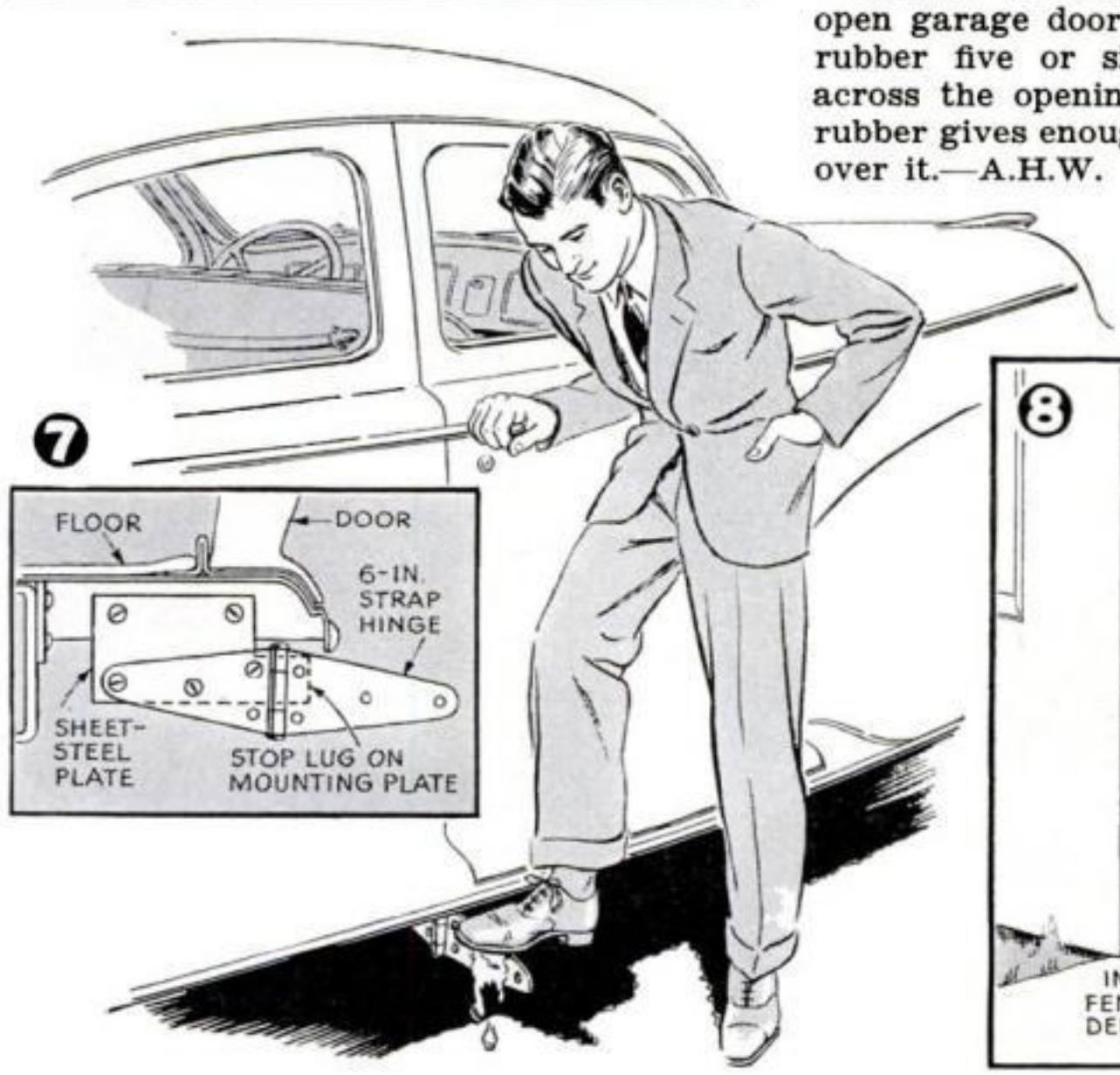

**5 A GLOVE-COMPARTMENT LIGHT** eliminates the annoyance of groping in the dark for licenses, maps, cigarettes, or other articles. Controlled by a door-jamb switch, the lamp goes on automatically when the compartment is opened.—P.N.

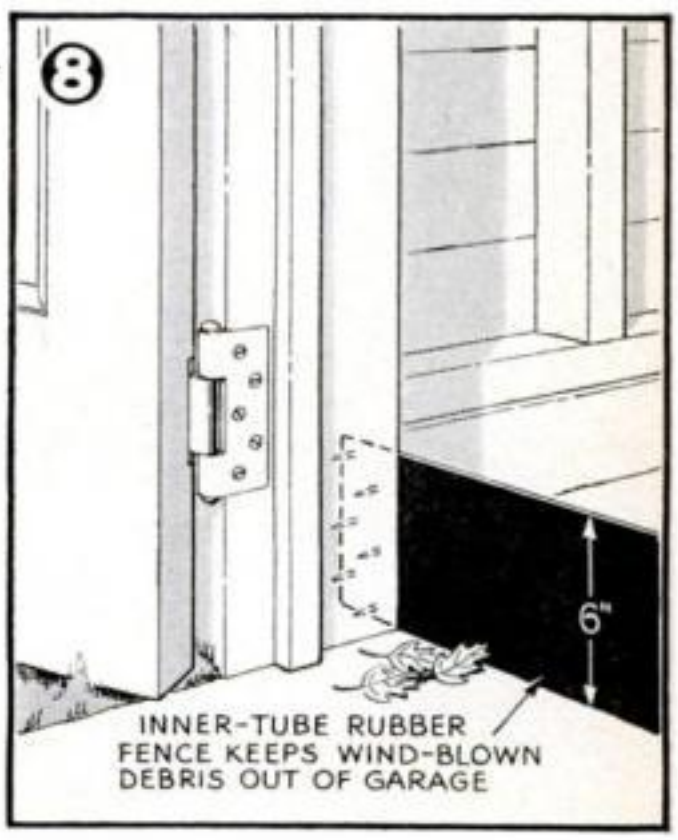
**6 COMPRESSING PISTON RINGS** can be done easily with a piece of wire and a pair of pliers. Loop one end of the wire firmly around a stud in the cylinder block and wind it once around the ring to be compressed. Pull the free end of the wire until the ends of the ring meet, and tap gently on top of the piston to force it down into the cylinder.—F. McC.


**7 RUNNING-BOARD FOOT SCRAPER.** The best way to keep the floor of your car clean is to install a foot scraper under the running board or body. A six-inch strap hinge is mounted on a steel plate, which in turn is fastened to the running-board bracket. A protruding end of the mounting plate serves as a lug to stop the hinge in the open position. When not in use, the hinge folds back out of sight.—E.F.

**8 RUBBISH FENCE FOR GARAGE.** Leaves and rubbish are kept from blowing into an open garage door by a fence of inner-tube rubber five or six inches wide stretched across the opening at the floor level. The rubber gives enough to allow the car to pass over it.—A.H.W.

DRAWINGS BY STEWART ROUSE



"Hey—watch it!" Joe yelled. A snappy convertible almost ran him down


# YOU can't be too careful!

*Two jobs in the same day prove Gus Wilson's contention that most automotive grief is caused by carelessness — the driver's or that of some bum mechanic*

**By MARTIN BUNN**

JOE CLARK stepped out of his office into the shop of the Model Garage just in time to be almost run down by a snappy convertible coupe being driven out by a decidedly peevish-looking young man.

"Hey—watch it!" he yelled, but by the time he got the words out the car was gone. He turned to his partner, Gus Wilson. "Say, that guy *is* in a hurry!" he complained. "What's biting him, anyhow? He looks sore as a wet cat."

"He *is* sore," Gus confirmed. "And he's got a right to be sore. I wouldn't blame him so much if he went back to the city and took a sock at the so-called mechanic who fixed up that job of his for him. But he won't—he's off to the Adirondacks on his vacation, and he's in a hurry to get there."

"Oh—then he's not sore at *us*," Joe said relievedly. "I'm glad of that. I hate to see a customer driving out of the place with a face like that on him. What's his trouble?"

"No trouble—now," Gus told him. "He drove in an hour or so ago with his radiator steaming and told Bill that it was clogged up. Bill just took his word for what was the matter, and reverse-flushed the radiator and then took the car out for a road test. He was back in 15 minutes, cussing—the engine had overheated again. He asked me to take a look, and while I was getting ready to do it the customer told me that just this morning he'd got his bus out of a shop down in the city, after having his engine tuned up and everything else checked to make sure that he wouldn't have any trouble while he was on his vacation. I asked him if he'd ever been bothered before by having this

car overheat, and he said that he hadn't.

"I figured that probably his timing was screwy, so I started to check it. Right off the bat I noticed that one of the cables was loose on a spark plug. Then when I tried to tighten the cable, I felt the plug move. Then I tried 'em all, and they all moved. That was the tip-off—the fellow who had tuned the engine had forgotten to tighten the plugs, and of course that made the engine heat up. I tightened the plugs, and just to make certain drove the car a couple of miles down the road and back. Nothing the matter with the radiator—the water stayed right at the proper operating temperature.

"When I told the young fellow what had caused his grief he started to cuss, and he still was cussing when he almost hit you on his way out. Of course there's no excuse for that sort of driving, but I know just how he feels. I guess we all are careless sometimes, but there ought to be a law about a mechanic who's that careless. . . . There's your 'phone, Joe."

Joe went into the office and answered the summons. After a couple of minutes he stuck his head in at the door. "There's a blue sedan with Massachusetts tags stalled in front of Kilrush's store," he reported. "The driver says that Kilrush recommended us, and will we please tow him in, in a hurry."

"Tell him yes," Gus said. "Hey, Bill! You go get him, will you?"

Twenty minutes later Bill towed a blue sedan into the shop. Out of it jumped a young man who wore a Navy ensign's uniform and had a worried expression on what obviously was normally a carefree face. "Hi!" he greeted, a grin breaking through the gloom.

"Hi!" Gus returned, grinning back at him. "What's your trouble, Admiral?"

"Harding's my name," the ensign told him. "And it'll never be Admiral Harding unless you get this can I'm driving rolling in a heck of a hurry. If I don't get over to the Brooklyn Navy Yard by six o'clock I'll miss my ship, and then they're more likely to put me in the brig than to promote me. I'm not fooling, mister—this is dead serious."

"What's your trouble?" Gus asked again.

"Darned if I know," Harding told him. "I was visiting a friend away out on Cape Cod, and when I got an unexpected order to report aboard a ship in the Brooklyn Navy Yard by 6 p.m. today I figured that instead of taking the afternoon train yesterday I could stay the evening and make it all right by starting early this morning and driving like the devil. So I did that. I borrowed my friend's car—he'll pick it up when he comes down to the city next week. It went along swell until I got into your town, and then the engine stopped dead. I know a little about cars, and I fooled around with it for maybe half an hour, but it wouldn't start. Then the fellow who runs the store came out and told me about your garage, so I called you up. The more swift you put onto getting this can rolling again, the bigger favor you'll be doing me. I've *got* to get aboard that ship before she sails!"

"YOU will," Gus assured him. "I'll drive you down myself, if necessary. But first I'll give your car a quick checking over. Are you sure that nothing happened before the engine quit—that there wasn't any unusual noise, or any warning of any sort?"

"No, not a thing—" Harding hesitated. "Yes, there was, too. A sort of whistling noise. I noticed it when I was driving with Joe—that's my friend's name—yesterday. He said he'd been hearing it, off and on, for a couple of weeks, ever since he'd had his engine painted, but that it didn't seem to mean anything. I heard it several times today—and, come to think of it, every time I heard it, it seemed louder."

Gus glanced at the shop clock. "If you leave here within a half hour you'll have plenty of time," he said. "So I'll see what I can do. . . . Starter all right?"

"Works fine," Harding assured him, "but

A young man in a Navy ensign's uniform jumped out of the car. "What's your trouble, Admiral?" Gus inquired

the engine just doesn't seem to take hold."

"How about your gas?" Gus inquired.

"Had the tank filled twenty miles back," Harding said.

Gus grunted, and started checking the fuel pump. It was working perfectly. And so was the carburetor.

"You're getting gas, all right," he said. "That means that the bug must be somewhere in the ignition system. Let's see, now, if we can narrow it down some more."

A glance showed him that the spark plugs were almost new. All the ignition wires were solidly anchored, and none of them was broken. A test established the fact that there was a very strong spark in the distributor. But there wasn't any spark at the plugs.

Gus pushed the peak of his cap down over one eye and scratched his ear reflectively. Harding pushed his uniform cap back on his head and grinned at him. "Got you stuck, too, hey?" he observed. "It's such a nice, shipshape-looking motor, too—but if Joe'd paid less attention to its outside and more to its insides, I'd be a lot better off."

Gus nodded as he regarded the freshly painted engine. Suddenly he snapped his fingers. "By gum," he said, "you've given me an idea. You said you heard a whistling noise, didn't you?" He took off the distributor cap, and then made the connection on the starter. Nothing happened. "There she is!" he said.

"There *what* is?" Harding wanted to know. "I don't see anything."

"You should be seeing that distributor butterfly turning," Gus told him. "But it isn't turning. That's the trouble. When it isn't turning no spark can get to the plugs, no matter how much juice there is in the distributor." He examined the distributor closely. "Yes—that's it, all right. See? The pin which should hold the gear on the shaft on which the butterfly is mounted has been sheared off." He glanced at the clock again. "I'll be able to fix it in time, all right."

"That's swell with me, mister," Harding said. "But what made the pin shear off, and what was that whistling noise I heard, and what did it mean?"

Gus worked while he talked. "When you come right down to cases," he said, "carelessness was the cause of your trouble. Before you can repaint an engine, you've got to get it clean. Whoever cleaned this one used a pressure hose. That was all right, but he was careless about where the water went. A little of it got into the distributor and ran down its shaft. That caused the grease in the distributor to harden, so that instead of lubricating the shaft it caused a lot of friction. Result: after a few hundred miles of running, the shaft froze in its bearing, and the gear pin sheared off. The whistling noise was caused by the friction, of course. Your friend Joe was careless about that; a driver always should check up on the cause of any unusual noise in his car. Some of them don't mean a thing, but others are the only warning you get of serious trouble."

Twenty minutes later, Harding stepped on the starter and the engine took off smoothly. He paid his bill, and then held out his hand. "I'm sorry I've got to shove off in such a hurry," he said. "I'd like to ask you to have a drink. It was darned nice of you to offer to take me down to my ship, in case you didn't have time to fix the bus."

Gus's face got red, the way it always does when anyone thanks him for a kindness. "You'd better step on it," he said, "or you'll still land in the brig. I wouldn't want to be the cause of your not getting to be an admiral—the way it looks to me, we're going to need a lot of 'em in the next 30 years or so!"

When Doc Martin dropped in for a chat just before closing time he found Gus busily writing in a battered blank book. "What are you up to—writing the story of your life?" he demanded.

Gus grinned. "Why not?" he said. "Others have done it. . . . No, Doc, I'm making a couple of additions to my collection of carelessnesses."

"Huh?" grunted the doctor.

Gus laughed. "I guess that word's not in the dictionary," he admitted. "What I mean is, a long time ago I realized that a considerable proportion of the automotive grief in the world is caused by someone's carelessness. Drivers are the worst offenders, of course—but they pay the bills. What gets my goat is a careless mechanic causing a car owner a lot of unnecessary trouble and expense. A couple of years ago I started to write *(Continued on page 202)*

## GUS SAYS:

That vacation trip probably will pile more mileage on your car than months of ordinary driving. It's just common sense to have a thorough check-over before you start, and keep close watch on tires, brakes, and lubrication all the time that you're on the road.

# HOME and WORKSHOP

Pools to mirror the beauty of your garden (NEXT PAGE)

HOW TO BUILD POOLS FOR AQUATIC PLANTS AND FISH

A garden within a garden is this tranquil lily pool. Its formal outlines are softened by a growth of border plants

# Outdoor Water Gardens

**BY CARL T. SIGMAN AND WILLIAM J. WARD, JR.**

MOST gardens should be planned about a focal point of interest, and perhaps no more satisfying central feature could be chosen than a well-built and tastefully planted pool. A grassy bank or a rocky landscaped ledge beside mirroring water may provide a delightful contrast to conventional flowers and shrubbery. The trickle of water over a stone cascade adds life and sparkle to the entire garden, and will do much to attract birds, especially during dry weather.

But, more than this, a pool may be a garden in itself. There are numerous beautiful bog and aquatic plants, such as water hyacinth, sweet flag, water poppy, marsh iris, and butterfly lily, that can be raised successfully only in or near water. A pool may also be stocked with goldfish, and one rarely tires of seeing these colorful creatures darting about among the lily pads.

If your garden is planned around some other feature, such as a sundial, arbor, or pergola, a pool may nevertheless be built as a secondary point of interest, tucked away, perhaps, in a sunny corner. In choosing a location, however, remember that aquatic plants require plenty of sunlight.

The ideal depth for a lily pool is 24", and fish may be kept in such a pool during the winter if it is fitted with a cover on which leaves are piled. Fish can also survive freezing temperatures in a pool 36" deep or more unless the water remains frozen to a depth of three or four inches for several days, in which case the fish will suffocate.

The simplest method of construction is that of sinking a ready-made tub or pool into the ground. In Fig. 1 is shown a steel pool that may be purchased in two rectangu-

lar sizes, 1½′ by 3′ by 5′, and 1½′ by 4′ by 7′. There are also available white-cedar tubs in several sizes (Fig. 2). Surrounded with flagstones, one of these makes a very pleasing little pool.

However, you can build your own water garden in any size desired by using reënforced concrete construction. The contour may be formal, such as the shapes suggested in Fig. 3, or pleasingly irregular. Concrete pools with sloping sides may be made without the use of forms. To make pools with vertical sides, forms are usually required, although there are two types of vertical-side pools, to be described later, that can be made without forms.

For the simpler sloping-side pool, the ground is first dug to the desired depth, the angle of the sides being made less than 45 deg. The excavation should be deep enough to allow for a subsurface of gravel 4″ to 6″ deep, which should be well tamped in place, as shown in Fig. 4. Then 3″ of concrete should be poured over the gravel. On this first concrete layer, suitable reënforcing is laid, followed by a second pouring of 4″ of concrete. Tamp this layer well into place and finish the surface with a wooden float.

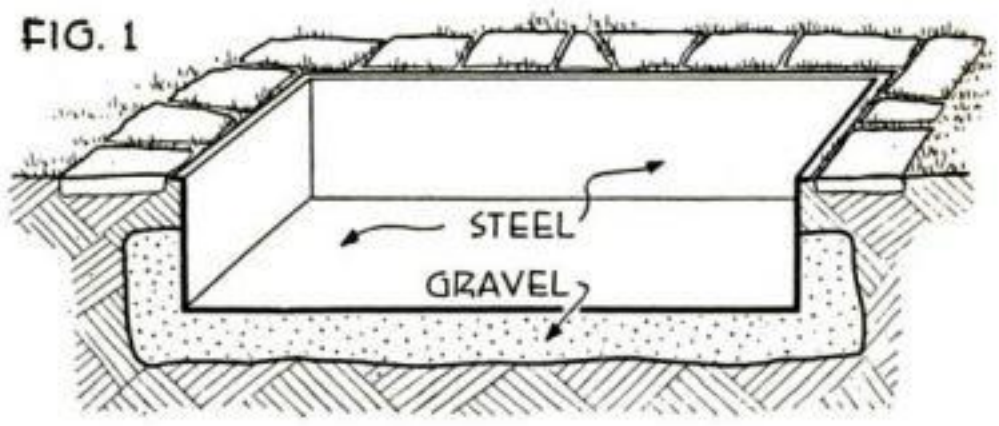
A proper mix for concrete for all types of pools is 1-2-3. A bag of cement is equivalent to one cubic foot. To this add two bags of clean, hard sand free of silt or loam, and three bags of ¾″ coarse, hard aggregate—gravel or crushed stone. Mix with 5½ gallons of water per bag of cement. If possible, allowance should be made for any water in the sand and gravel. This may be as much as a gallon per bag of cement used in the mixture. Be sure to mix the sand, gravel and cement thoroughly together before adding the water, and equally thoroughly afterwards. Have a mortar box about 5′ by 8′ for mixing, and be sure to make enough concrete so that the pouring can be completed without mixing more.

For reënforcement use ⅜″ deformed reënforcing bars laid checkerboard fashion 6″ apart. These rods should be fastened together at every joint with stove-pipe wire. Where the rods are joined end to end, they should overlap 6″ and should be tied with wire.

A reënforcing that is easier to use and equally effective is 40-pound mesh. Where the pool is irregular in shape, mesh is easier to handle than the ⅜″ rods. Adjoining pieces of mesh should be overlapped one square and tied together with wire. Where two sides come together or where a side and bottom join and the reënforcing cannot be continuous, join the two sides with a third piece of mesh bent to the proper angle to overlap both parts at least one square, and secure with wire. In addition to this reënforcement, a ½″ bar should be placed around the top of the wall 2″ below the surface.

Two types of sloping-side construction are shown in Figs. 5 and 6. That having a grass bank coming down to the water level requires the use of a form around the top. This may be made of stakes and ½″ waterproof plywood. Be sure that the concrete comes 1″ above the proposed water level

FIG. 1



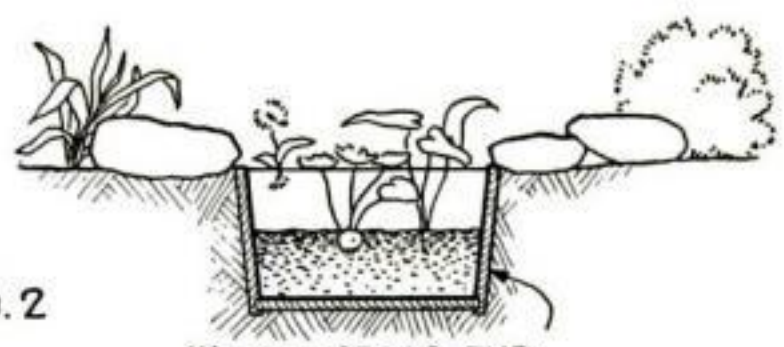



FIG. 2

WHITE-CEDAR TUB

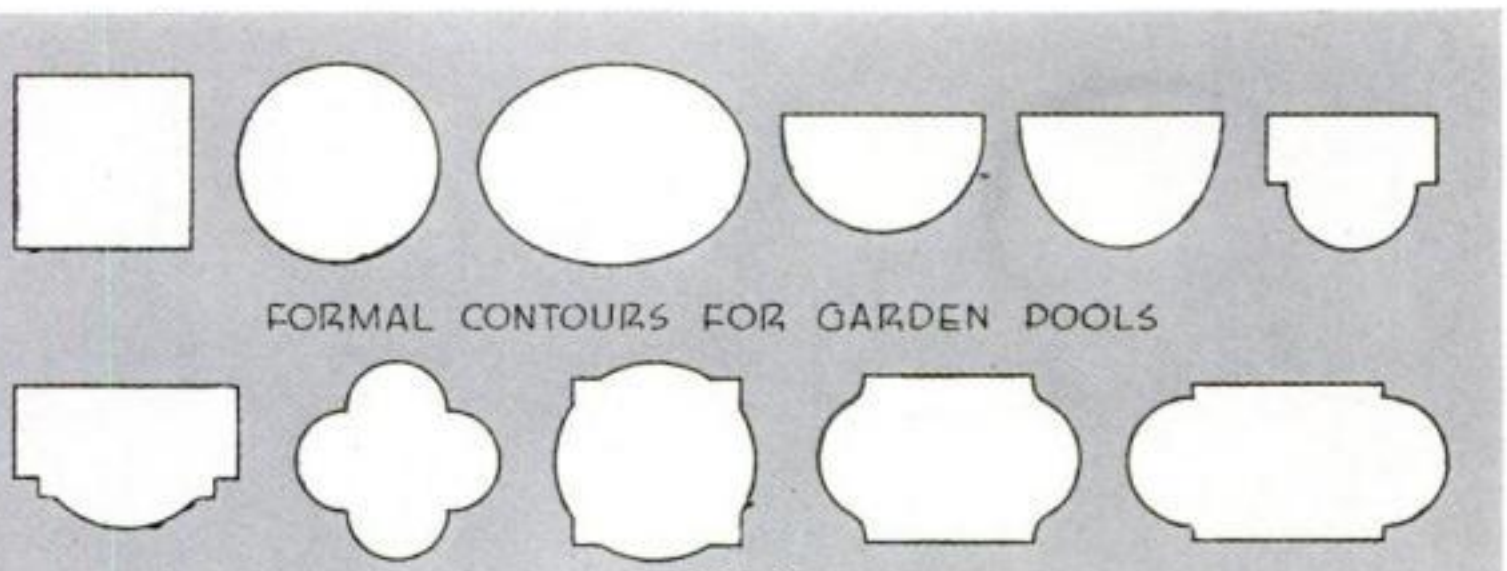



FIG. 3

and that the top edge of the plywood form is level all around. When the cement has set, the form may be removed and earth filled in around the concrete edge. Sod must be cut in pieces about 12″ wide if it is to be laid close to the water level. If you plan to have a naturalistic edging of stone, a shelf similar to that shown in Fig. 6 must be provided 6″ to 12″ below water level. Before the concrete on the shelf has set, score it lightly. This will afford a better bond with the cement mortar in which the stones should be laid. The reason for building the shelf 6″ to 12″ below water level is that this depth is necessary for the growth of bog plants between the stones.

In Figs. 10 and 11 are shown methods for providing a permanent edging for bog plants in vertical and sloping-side pools. The inner wall of the pool in Fig. 10 can be finished with a brick coping, or for a natural effect rocks can be laid on top of it and the earth filled in behind them. Beside the drawing of the wall section is shown a method for building a form for this pool.

The mix and reënforcing for pools with vertical sides are similar to those described before. A good type of form may be seen in Fig. 7. Note how the framework is suspended from the banks. The lumber used need not be lost, but can be used to make a winter cover for the pool.

In making the form, the vertical 2″ by 4″ studs should be spaced 20″ on centers. The sheathing may be tongue-and-groove stock or waterproof plywood. Instead of wires for holding the horizontal studding in place, a combination spreader and strut now on the market can be used.

The concrete is mixed as described,


At left: A, water lilies; B, arrowhead; C, papyrus; D, taro; E, pickerel rush; F, water hyacinth; G, forget-me-not

Below, tropical water lilies grown by William Tricker, of Saddle River, N. J.

and the bottom and sides poured at one time. Leave the forms in place for 48 hours, and keep the surface moist with wet burlap or straw. Weaknesses will develop in a pool which is permitted to set too quickly. After the form has been removed, fill in the space behind the concrete with gravel to provide drainage.

A simpler method of building a vertical-side pool is to make a form for the inside surface only, one wall of this form being braced against the other. The excavation becomes the form for the outside wall. If you plan to build a round or oval pool, see the recommended form in Fig. 8.

Still another way to build a pool without forms is to follow the method shown in Fig. 9. The floor is first poured over a sub-base of gravel, the reënforcing mesh being allowed to stick up one square or, in the case of rods, 6". Join the vertical reënforcing to this with wire, then lay up a brick wall 6" away from the edge of the excavation. The concrete is poured between the soil and the brick. Finally, face the brick wall with a 1" layer of cement mortar. After the concrete has set, the earth may be cut away for 6" behind the concrete to the depth of the wall, and gravel tamped in between.

No matter what the type of form used, concrete walls should be poured in successive layers 6" to 8" thick, and not all at once. Chop each pouring of concrete with a spade to eliminate air holes.

There is a still simpler, although less satisfactory, method of building a vertical-side pool. This is to stake out the desired shape and excavate a trench about 8" wide and about 34" deep all around. Into this the reënforcing is set and the concrete poured. The sides of the trench must be smooth and hard. Wait several days for the concrete to set, then excavate the center of the pool to a depth of 32" to 34", lay a well-tamped gravel base about 4" deep, and pour a 6" reënforced concrete floor. Finally, paint the inside of the pool with a waterproofing coat of pure cement and water. This type of pool should be relined thus every year, because it is sure to develop cracks.

When your concrete pool is finished, fill it with water and allow it to stand filled for four or five days in order to leach out the alkali. Free lime leaching out of the cement while it is setting would kill aquatic plants and fish. Drain off this water

Its irregular shape and rocky edges are in keeping with the setting of this pool in the home garden of Mrs. C. I. DeBevoise, at Greens Farms, Conn.

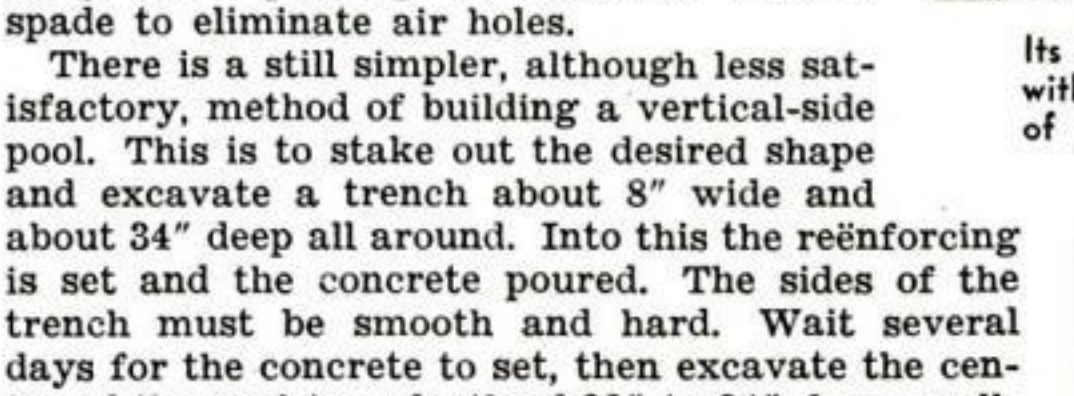



FIG. 4

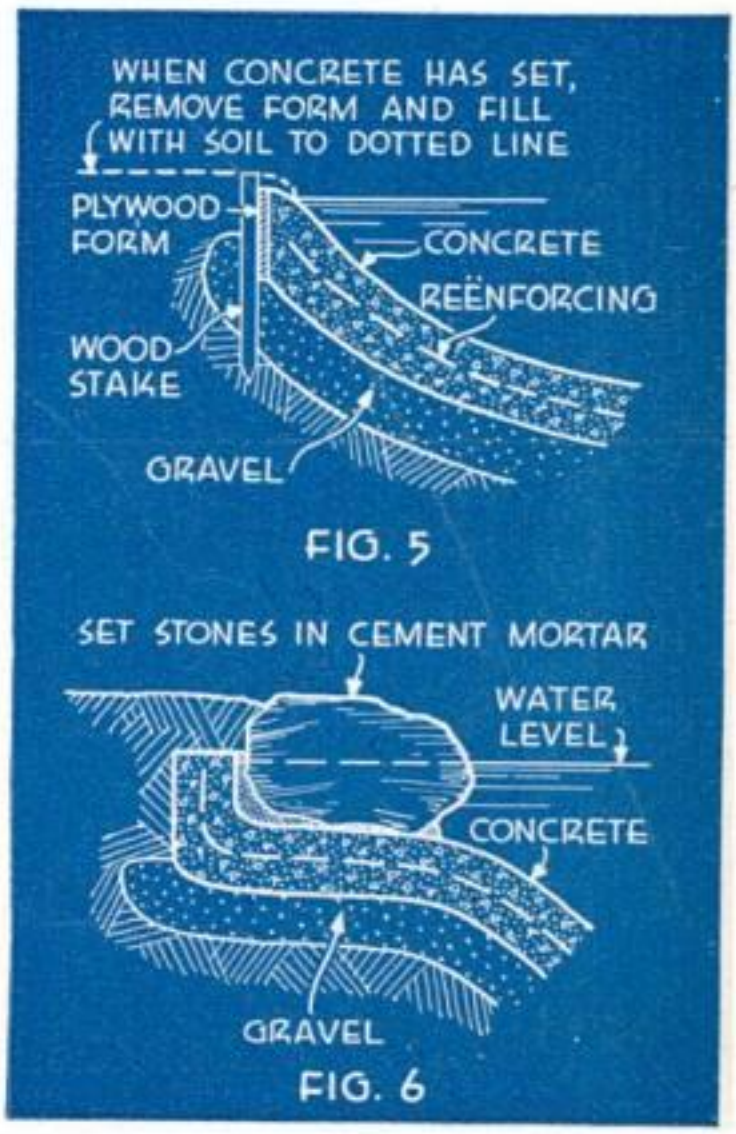



FIG. 5




FIG. 6

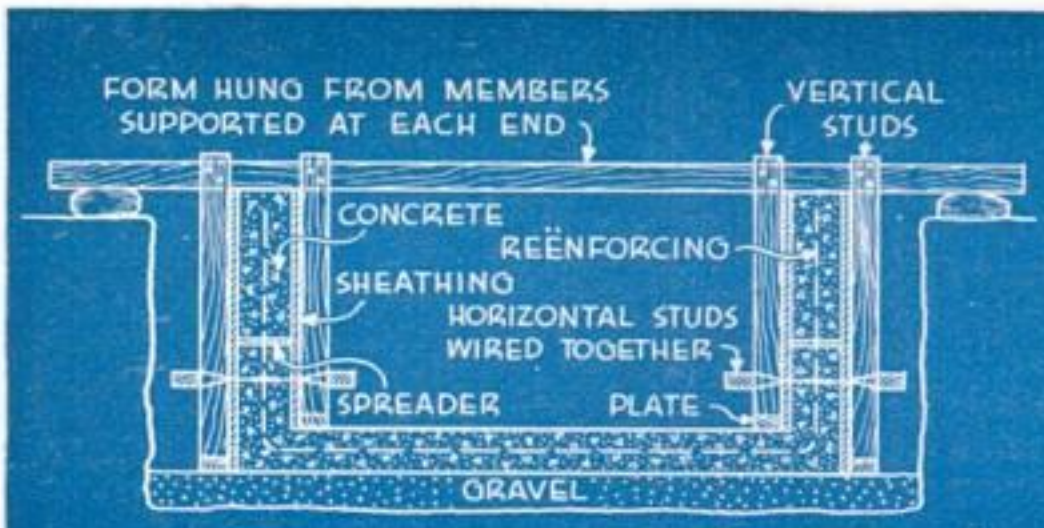



FIG. 7

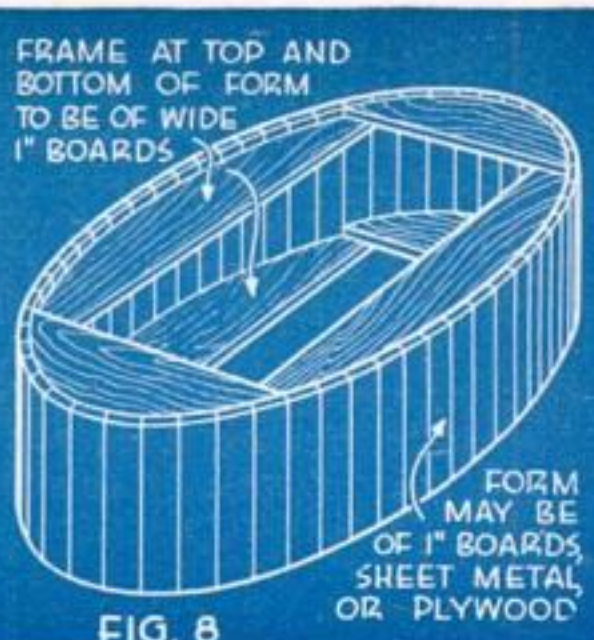



FIG. 8

and fill again, and after one day test the water with red litmus paper, which can be purchased at any drug store. If the litmus paper turns blue, the water is still too alkaline. Wait a day of two, test again, and drain off a second time. Probably the third filling will be satisfactory.

Fish often die in water that has become too acid because of fallen oak leaves or the like. Test for this condition with blue litmus paper. If it turns red, the water is acid.

If you plan to empty your pool in winter, it should have a drain at the lowest point leading to a sewer or dry well. This is also useful for disposing of water that has drained into the pool because of excessive rains. A drainage system such as shown in Fig. 12 will be satisfactory. By having an overflow drain screwed loosely into a brass coupling, the overflow pipe can be unscrewed in order to drain off the pool. However, a properly balanced pool need be drained only once a year, and an ideally constructed pool would not have to be drained at all.

For proper drainage of ground water, there should be around the sides and below the floor of a pool a 6" layer of crushed stone, gravel, or coarse cinders. It would be advisable to lay a clay tile pipe with open joints at the bottom of the drainage material to carry off the ground water. This pipe should be run to a sewer, dry well, or lower open ground. A dry well will serve only where the soil is relatively sandy and permits water to seep away.

If a water supply system or a fountain is to be built in the pool, a ½" supply line may be controlled by a gate valve set in a clay tile pipe as shown in Fig. 12. This supply line should be well below frost or else so pitched that it can be completely drained before freezing weather sets in.

A more elaborate addition to a pool is the cascade shown in Fig. 14. The flow of water need not be great. A mere trickle over moss-covered stones is often more desirable than a tumbling fall, and if a small pump is installed it is possible to use the same water over and over.

Water lilies are easily grown and require little care if properly planted. Each plant or root should be set into a box or tub containing not less than one and preferably two cubic feet of soil. For aquatic plants a mixture of three parts of fibrous loam or good garden soil and one part of well-rotted cow manure should be placed in a box or other container. The top should be from 6" to 8" below the water level, and the container should be 6" to 12" deep, as shown in Fig. 13.

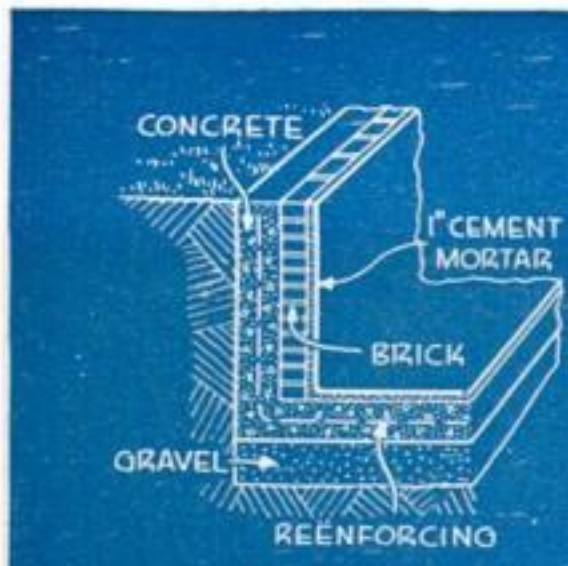



FIG. 9

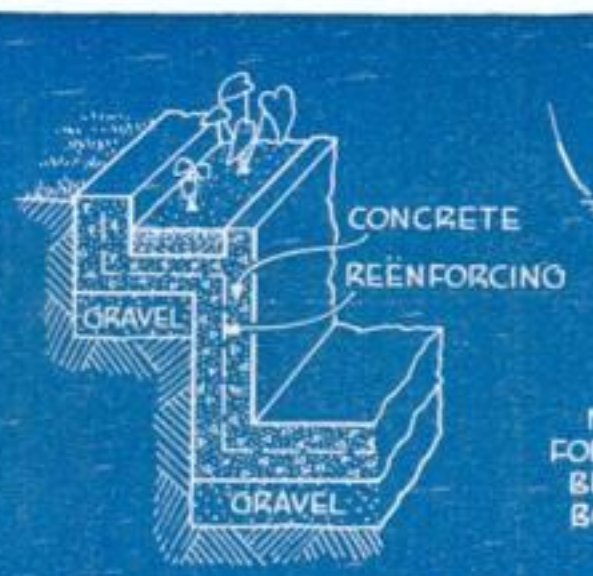




FIG. 10

Plant water lilies with the crown just even with the surface of the soil, and cover the latter with an inch or two of sand or gravel to keep the water clean. The plants should be set 3′ to 5′ apart. It is not necessary to drain the pool before planting, as the roots can be pressed into the soil under water.

New plants are best set in water not more than 4″ deep over the box of soil. Later this may be increased to 6″ or 8″. You can plant water lilies any time from April 15 until well into summer. Greenhouses that sell water lilies ship half-dormant roots from April 15 until June. After that, when the temperature averages 70 deg., growing plants are sold.

Lotus tubers look very much like large bananas. They should be planted about 2″ deep in rich soil, in a horizontal position. A container not less than 24″ in diameter and 10″ to 12″ deep is essential to assure satisfactory growth and flowering. The weather should be quite warm before tubers are transplanted, for if planted in cold water, they very often fail to grow. The water should be shallow, not more than 4″ above the soil at the start. As the plants develop, the depth can be increased to 6″ or 8″. Pot plants are simply tubers started in the greenhouse in pots for late planting. These are turned out of the pots and planted in rich soil in 4″ to 6″ of water. Large containers such as recommended for tubers are necessary. Lay lotus root down and press gently into the soft mud. If it shows a tendency to float, put a stone or brick on it until it takes root.

Every pool needs oxygenating plants to keep the water clear and pure. These grow under water and absorb impurities while

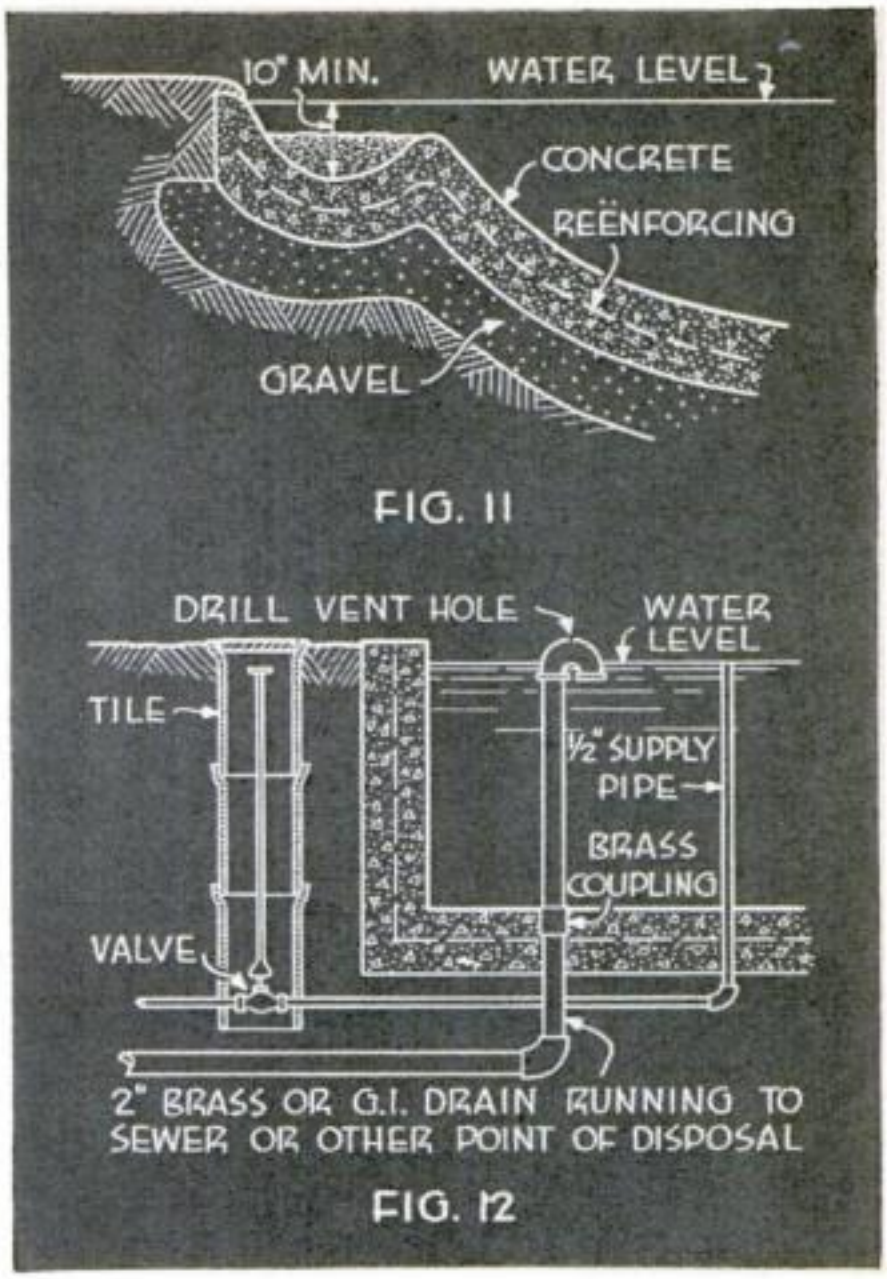


FIG. 11



FIG. 12

liberating oxygen, which action clarifies the water and helps to prevent the growth of algae that turn the water green. Oxygenating plants are indispensable when fish are present. They also assist materially if young fish are to be raised, as these find shelter and protection among the foliage.

Use small boxes or 5″ pots and set the oxygenating plants in soil. Fill the containers to within 1″ of the top and use sand in the remaining space. This prevents muddying up the water when the plants are placed in the pool. Set the boxes or pots directly on the bottom, between the lilies. A 5″ pot is large enough to accommodate about three plants. Oxygenating plants should never be planted in the same container with lilies.

In addition to oxygenating plants, pools should have scavengers. Snails destroy algae and green scum, tadpoles eat decayed matter, and fresh-water clams and mussels keep the water clear. Tropical fish destroy mosquitoes and other insects. Scavengers can be purchased in sets for pools of various sizes, as, of course, can aquatic plants.

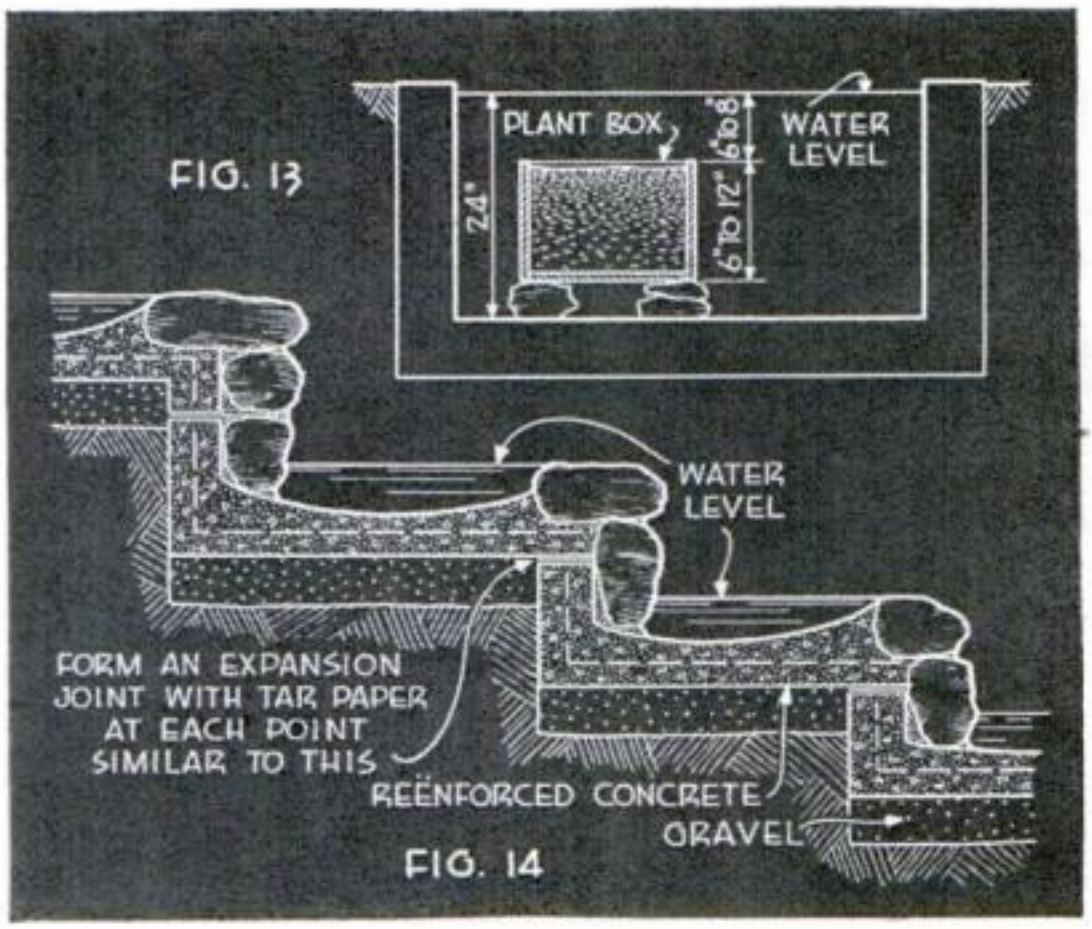


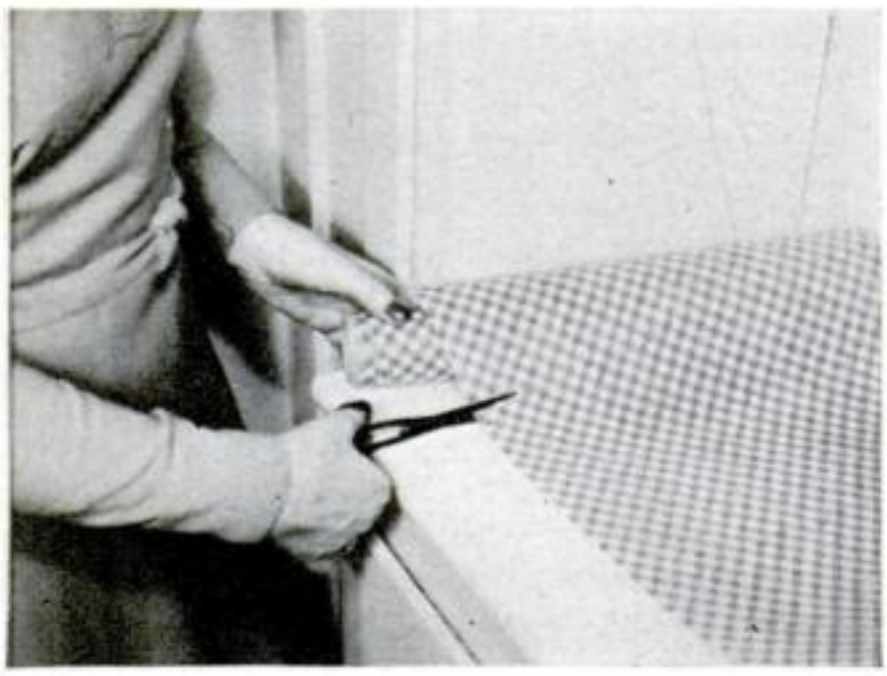
FIG. 13

FIG. 14

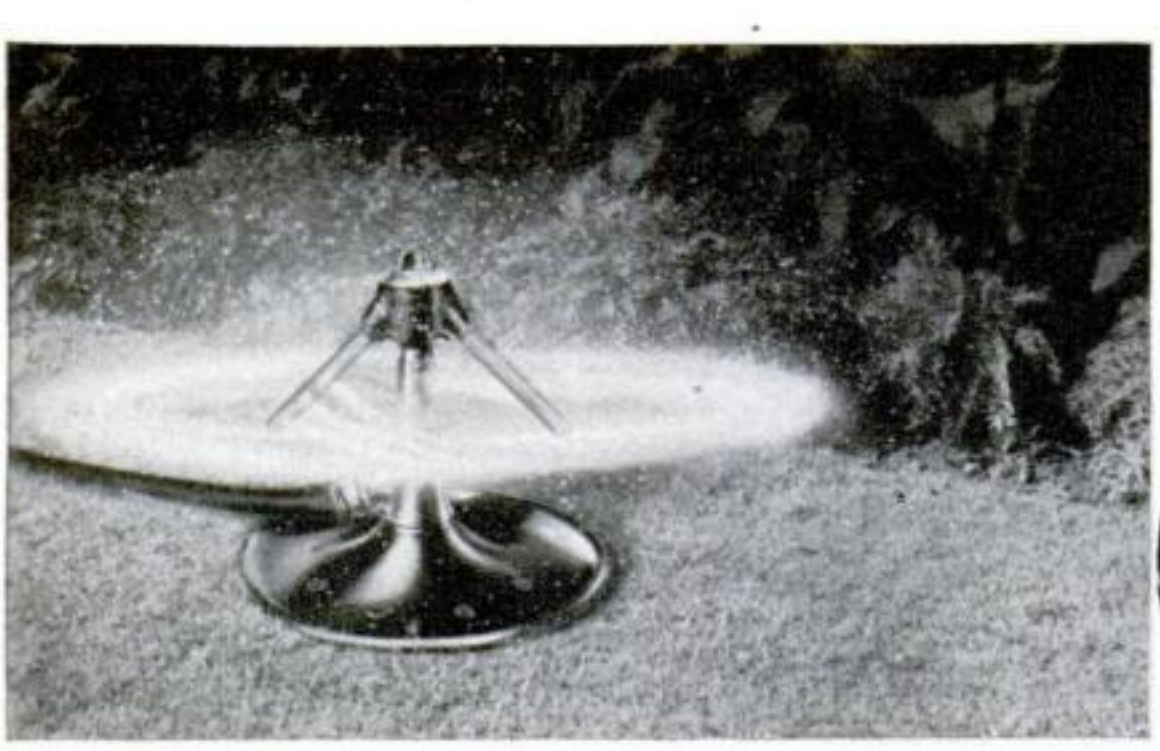
# IDEAS for HOME OWNERS

**SHELF AND LINING PAPER** having a plastic coating bonded to its surface is now available in colors, both plain and with patterns. The molded coating is greaseproof and waterproof, and does not deteriorate even after repeated wiping with damp cloths. Sold in rolls 13", 14", and 22" wide, the plastic lining paper is also suitable for covering books and other uses. It is expected to appeal to craftworkers for various purposes.

**WITH THE GRASS CATCHER** shown above, it is unnecessary to remove cuttings until the entire lawn has been mowed. The weight of the clipped grass rests on two auxiliary rubber-tired wheels and is therefore readily carried along without extra effort. The catcher will hold all the cuttings from a large lawn. A trip mechanism aids in dumping the load after the lawn has been mowed.



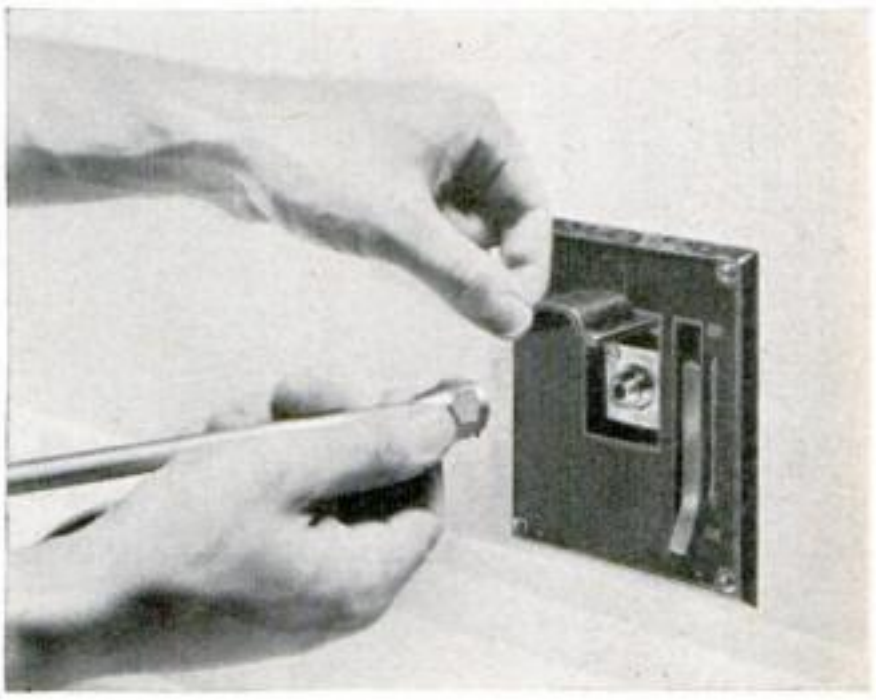
**THIS NEW LAWN SPRINKLER** can instantly be adjusted, by means of a control button, to throw its rainlike spray over an area from five to fifty feet in diameter. The amount of water is automatically regulated to irrigate most efficiently the space for which the sprinkler is set, and the revolving arms produce a fine shower that is suitable for both newly seeded and fully grown lawns. All the exposed brass parts are chromium plated. The revolving head and body are of cast iron, and the bearings are made of long-lasting phosphor bronze in order to insure continuous efficiency over a period of years.

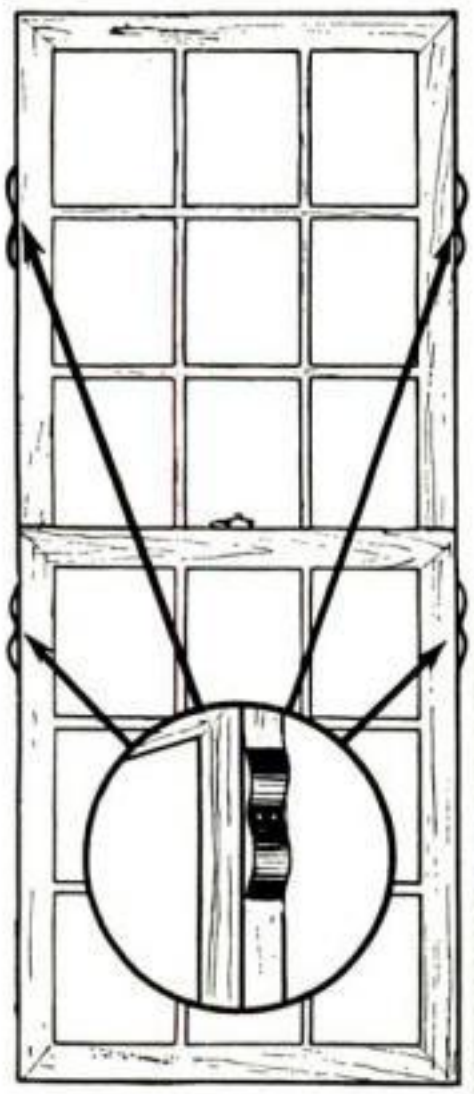


Turning a control button adjusts this lawn sprinkler to irrigate large or small areas. The base is made of pressed steel

**RESEMBLING A ROTARY MOTOR TOOL,** the device shown at the right has a reciprocating action, and can be used for many operations that heretofore could be done only by hand. Files, hones, saws, gouges, and wood or steel chippers can be used interchangeably in its chuck, and its practical applications range from chipping tiny rock specimens under the microscope to burring steel forgings on production work. Various models are available, with strokes of from 1/8" to 7/16". All are powered with universal motors so that they will run on A.C. or D.C. current.

**A BUILT-IN GAS OUTLET,** to which heaters and other gas appliances can be connected almost as conveniently as electrical devices are plugged into the familiar household receptacle, is designed to be set flush into the wall. A molded plastic cover plate fits over it, and is available in ivory and walnut to match interior color schemes. Connection is made by means of a threaded coupling, which cannot be accidentally loosened. Metal tubing replaces the usual flexible hose. A patented safety shut-off valve is incorporated in the outlet itself, and makes it impossible to turn on the gas at that point unless an appliance is actually connected and ready for use.





Four springs suffice for a double-sash window. On repair work, they are inserted as shown at right

**SEVERAL COATS OF PAINT** can be removed at one scraping, it is claimed, after application of a new solvent containing no acid or alkali. As it does not leave a waxy residue, no washing or neutralizing is necessary, and removal of the old finish is said to be accomplished in 25 percent less time. The new finish can be applied immediately. As the paint remover remains wet in use, a large area may be treated before stripping is begun.

**WINDOWS WITH BROKEN CORDS** or pulley stiles can be repaired quickly and permanently by inserting small flat springs such as are shown at the left. It is not necessary to remove the window from its frame. Made of noncorrosive phosphor bronze, the springs hold a window at any desired position in the same way weights would, and also prevent rattling. In fact, they are being used in certain types of new construction work in place of the more expensive sash weights and cords.

# KEEPING

BOTH PRIVACY AND VENTILATION are assured by screening a doorway with a roller shade hung as above. When closed, it takes up no room. Brace the lower bracket as shown. Screw eyes set in the shade stick slip over hooks in the opposite jamb

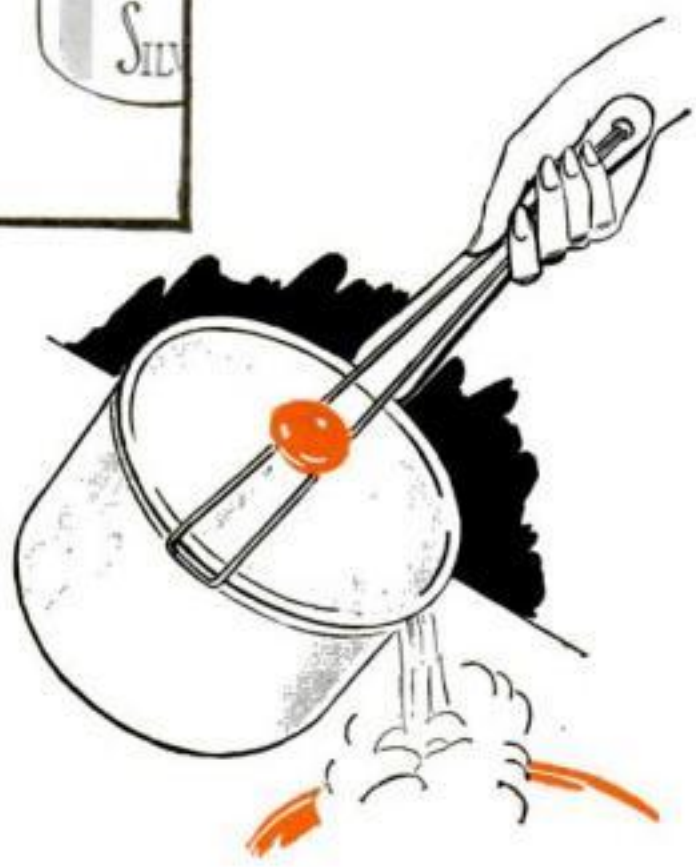
TO ATTACH A SOAP DISH to the inside of a bathtub, bolt a rubber suction cup to the metal fixture provided, and slip it into place on the dish. Smear soap generously on the edge of the cup. The dish can, of course, readily be removed

IT IS OFTEN DIFFICULT to remove the smooth covers of hand-soap cans, especially if the hands are greasy. Two rubber bands cut from an old inner tube, stretched over the can and cover as at the right below, afford the fingers a good grip


SILVERWARE having a chased design is often hard to clean thoroughly with an ordinary cloth pad. A small brush of the kind used to apply mascara will remove dirt and polishing paste even from the bottom of fine engraved lines

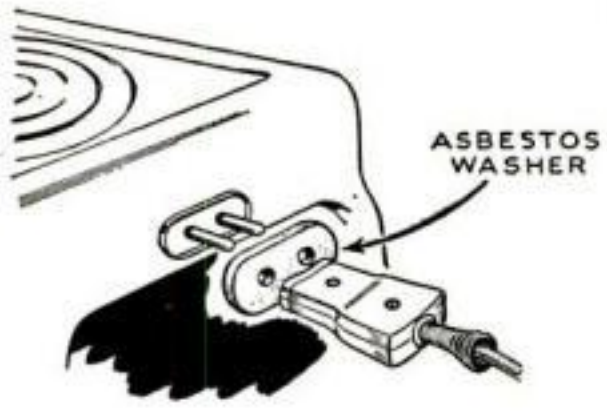
KEEPING A COOKBOOK CLEAN when following a recipe is easy if a piece of glass with smoothly ground edges, such as a small glass shelf, is laid over the open pages as shown below

AT THE RIGHT is shown a lid holder that can be bent from stiff wire or a coat hanger. The ends are held together with the hand. To lift off a hot lid, unhook the looped end from the lip of the pot



# THE HOME SHIPSHAPE

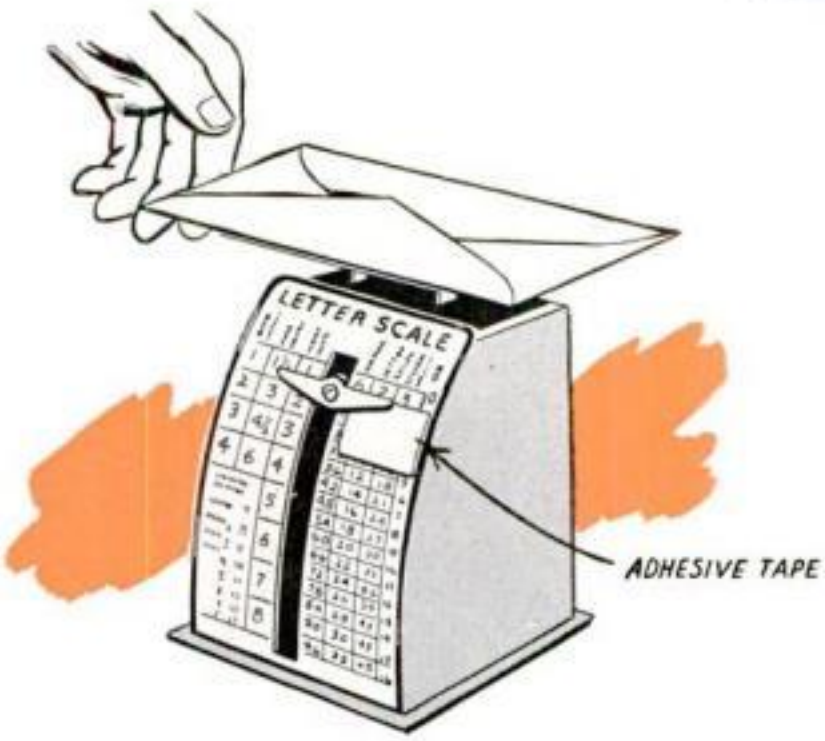
CRACKED WINDOW PANES can be repaired temporarily by filling the break with Canada balsam, such as microscopists use for mounting specimens. If necessary, thin with turpentine or lacquer thinner. Allow balsam to harden a few days, then scrape off the excess with an old razor blade




CONNECTING PLUGS on appliances such as toasters and percolators may be given additional protection from the heat by slipping asbestos washers, cut from a table pad, over the two contact prongs

GARMENTS WILL NOT SLIP off coat hangers if small rubber crutch tips such as shown above are slipped over the ends. The tips can be bought in various sizes


IF THE RUBBER BULB of a medicine dropper is lost or torn, a substitute can be made from a short piece of rubber tubing. Close the end with a ball bearing or a bead, and seal with wax




SCREENS CAN BE INSTALLED without hangers or other hardware by drilling holes through the frames near the corners, putting the screens in place, and drilling through the holes for about an inch into the window frames. Insert ordinary nails as above. Use six for full-length screens

WHEN A LARGE NUMBER OF LETTERS are to be stamped, sorting out those requiring extra postage is speeded by sticking a bit of adhesive tape under the one-ounce mark on the scale, as at the left. Overweight letters bring the pointer over the tape, and can be detected without eyestrain

# New Walls for Old

## EASY-TO-FOLLOW DIRECTIONS FOR REDECORATING WITH WALL PAPER

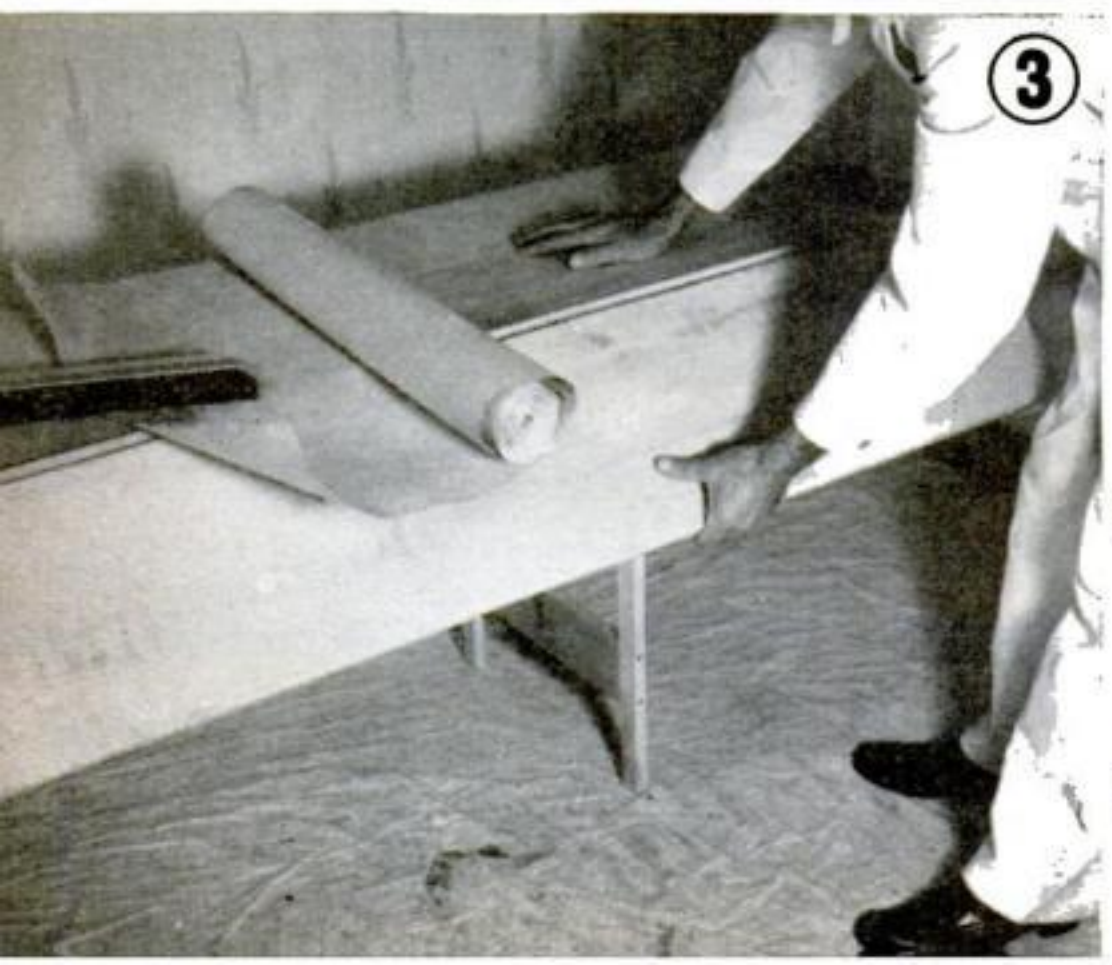
By BENJAMIN NIELSEN

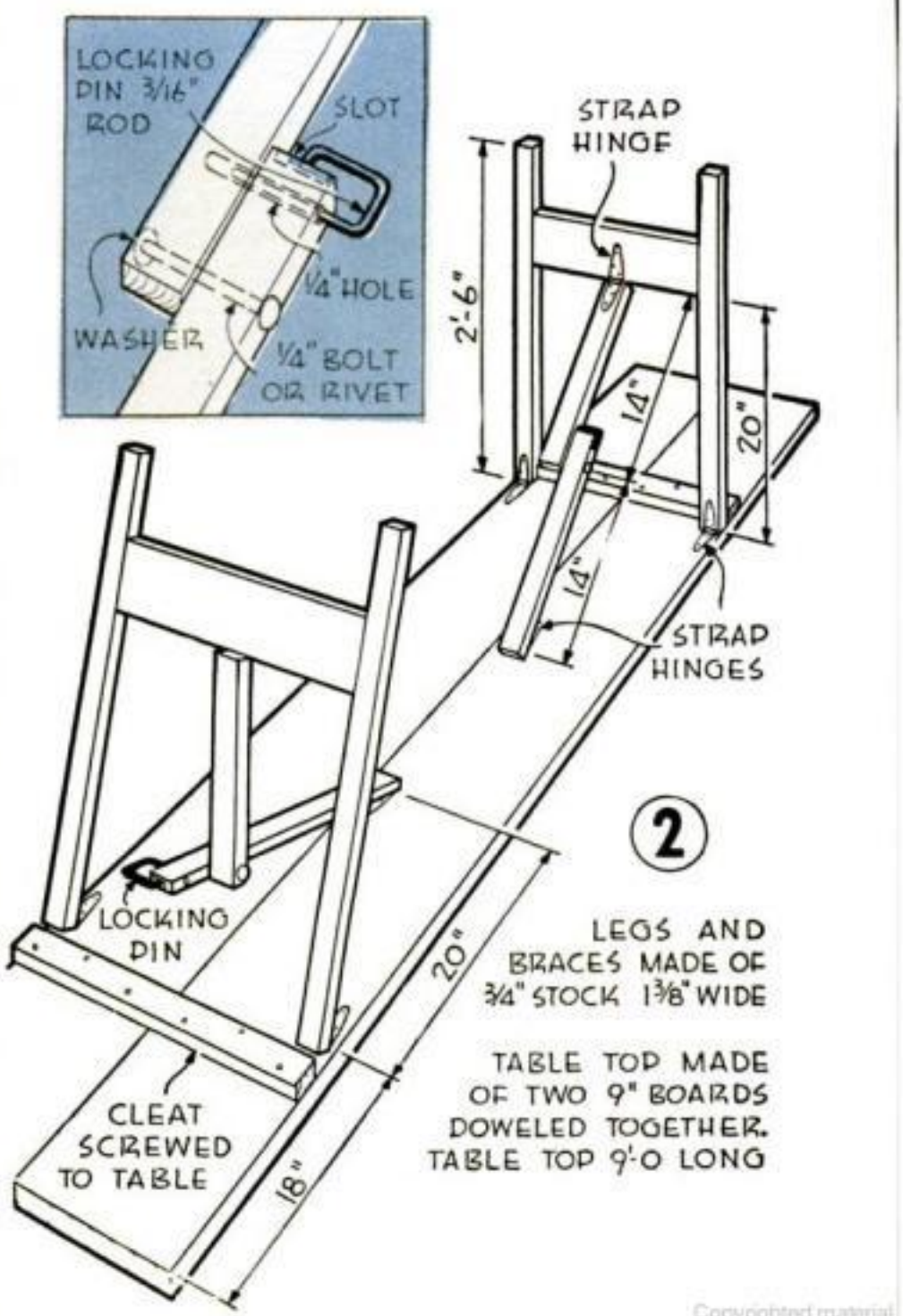
### PART I

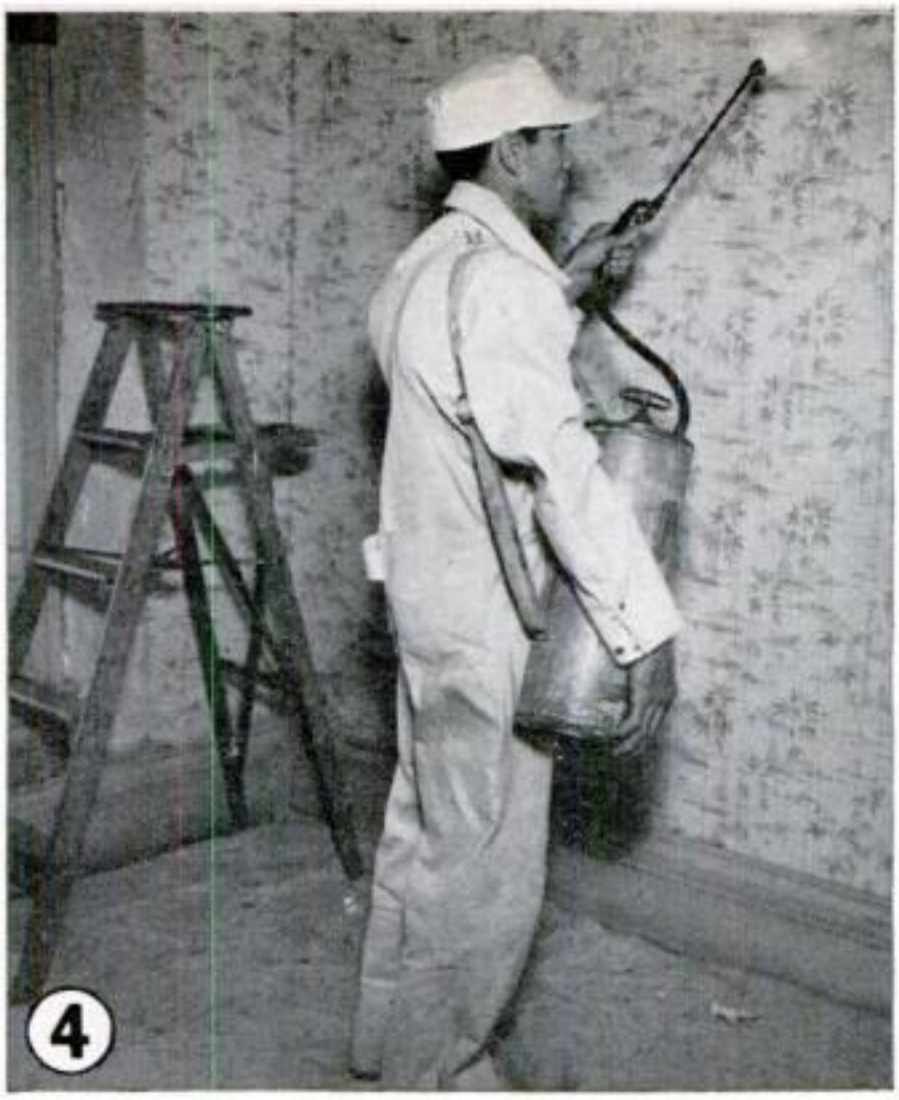
AT THIS time of year, you can't help noticing dingy wall papers. They seem to cry out for some one to do something about them.

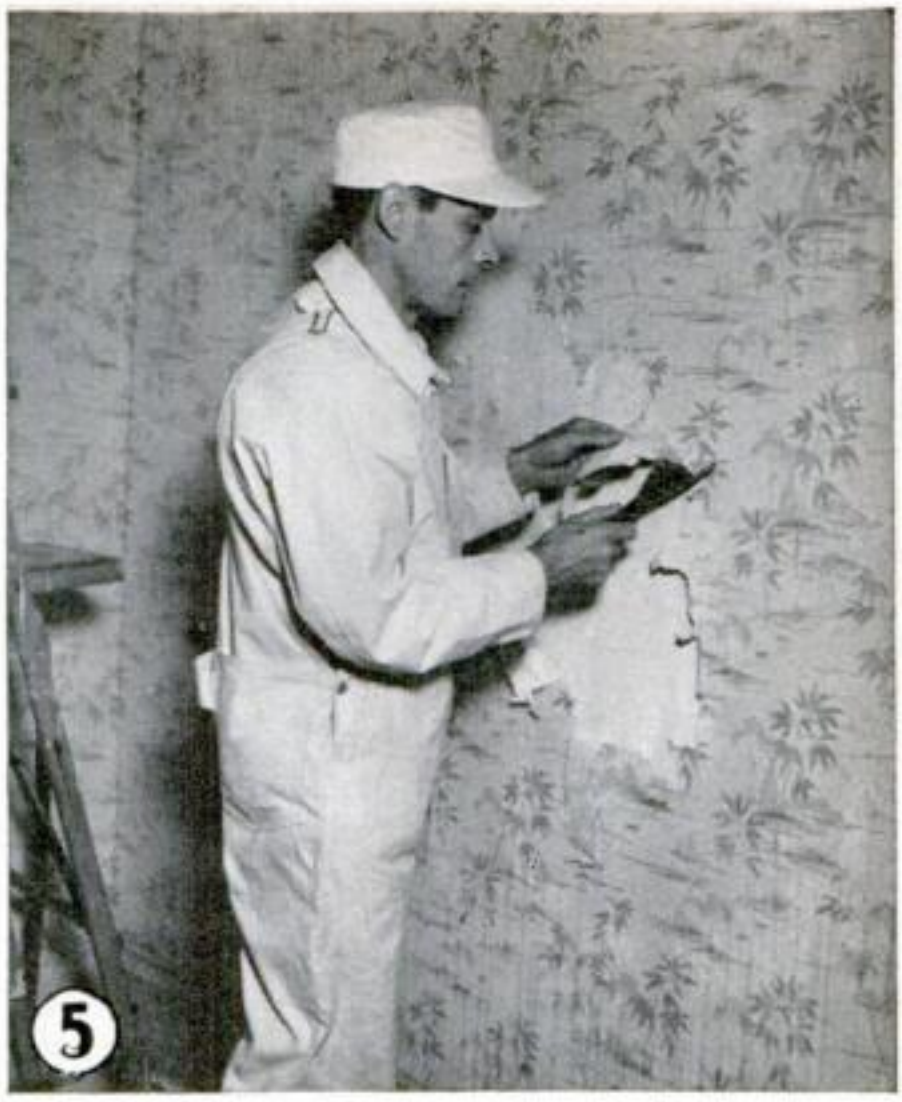
Perhaps you have already said to yourself, "I wish I knew just how to go about hanging wall paper!" But you may have given up the idea because you think that it is difficult to learn and that you would need various special tools or exceptional skill in order to do presentable work. Such is not the case at all. Any amateur mechanic who is reasonably handy at making household repairs can master the few simple tricks essential to turning out a good job.

It is possible to do expert work with the simplest of tools. The essentials, which are shown in Fig. 1, consist of a paste brush, smoothing brush, trimming knife, wide-blade scraper, yardstick, shears, seam roller, rotary trimmer, and straightedge. The latter may be improvised by planing a true edge on a 6′ or 7′ length of hardwood with a jointer plane or on a small power jointer. This edge may be tested by drawing a thread tight along the table and placing the wood against it. The




thread should touch the straightedge along the entire length. The other tools may be purchased singly or in sets at most well-stocked paint or hardware stores.

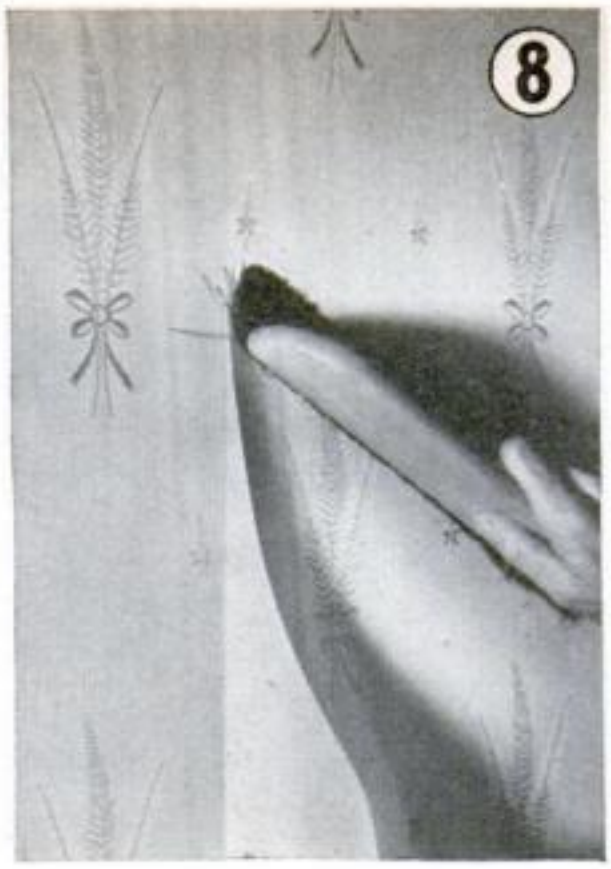
In addition, you will need two stepladders and a sturdy plank for use in papering the ceiling, and a lightweight table for pasting and trimming. Boards placed across lightweight horses of convenient height, made like sawhorses, will serve the purpose admirably. Or a good, serviceable table, such as the one shown in Fig. 2, may be made at a very reasonable cost. Ordinary pine board, without knots, should be used. As this worktable may be folded, little space is required for storage. Its 9′ length makes it especially convenient because a full-length strip may be pasted without stopping to fold and slide the paper. Provision for accommodating 30″ wide paper when necessary is made by hinging a 12″ board to one side of the table (Fig. 3). Use two loose-pin hinges, which allow it to be easily attached or removed.

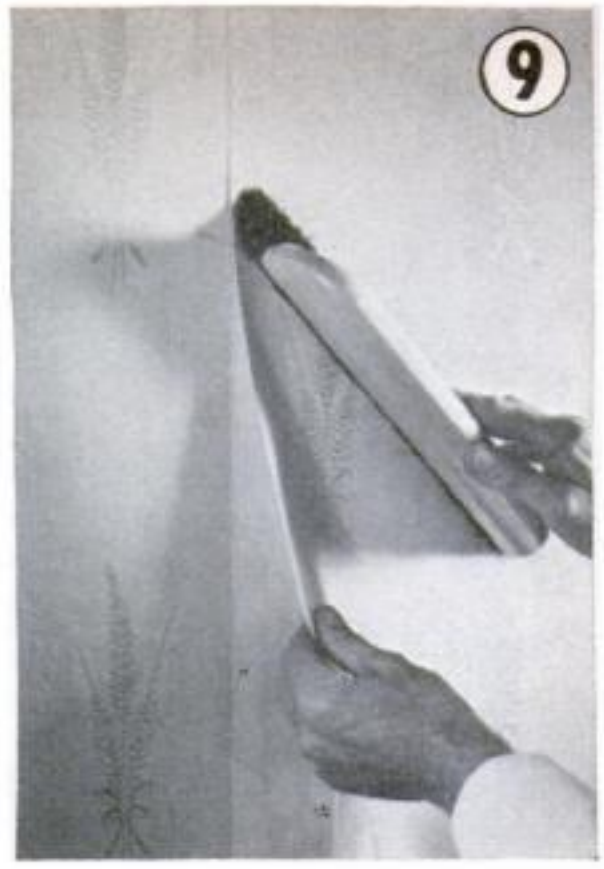
For a professional-looking job, the old paper should be removed. This is not always an easy task, but can be done by soaking the paper by means of a pressure spray outfit as in Fig. 4. It is best to use warm water for this. If a spraying outfit is not available, water may be applied with the paste brush. The entire room should be wet until it will absorb no more water; work progresses more quickly this way than if small patches are soaked here and there.

By the time you have finished soaking all the walls, the paper at the starting point should be loose enough to be readily removed with a wide-blade scraper (Fig. 5). Some spots may need additional wetting. A little ammonia, borax, baking soda, or sal soda may be added to the water to aid in softening up the old paste.


After the old paper is removed it is a good idea to wash the walls and let them dry. All cracks or holes should be repaired with patching plaster. Methods of doing this were fully covered in an article, "Repairing Inside Walls," which appeared last month (P.S.M., July '41, p. 148). Take great pains to make the surface perfectly smooth. After this has been done, the patches should be brushed with ordinary wall-paper size or glue size.

If painted walls are to be papered, they should first be washed with a solution


of sal soda, a cupful to a pail of hot water. After they have dried, they must be sized. Commercial size is available at a reasonable cost, and instructions for its use are printed on the package. Size can also be made by stirring 4 oz. of white glue into 2 quarts of hot water, larger amounts being made up in the same proportions. This should be applied with a wide brush while still warm.

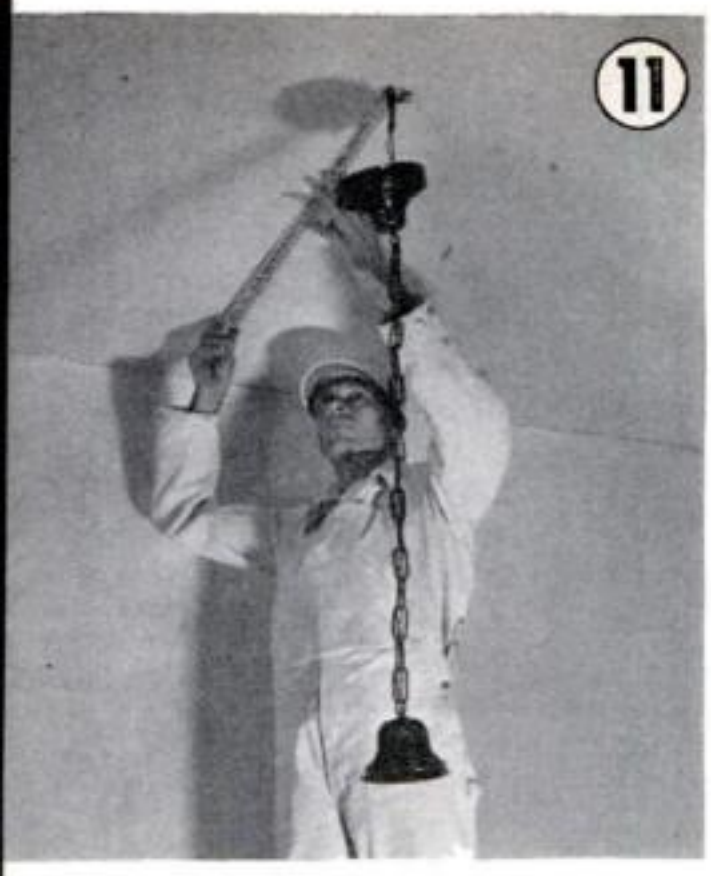
An accompanying tabulation will quickly show you how many rolls of side wall and ceiling paper you will need, and how many yards of border. For room sizes not listed, calculate in square feet the area to be papered. Divide the total by 60 to determine the number of double rolls of paper needed. Deduct one double roll of side-wall paper for every four openings of average size, such as doors, windows and mantels.

Good commercial paste may be purchased in powder form in 5-lb. packages at reasonable cost, or an equally good cornstarch paste may be made at a small saving. Cornstarch paste has the advantage of not staining if a bit is accidentally smeared on the face of the paper. To make it, pour a quart of cold water in a large pail and add two thirds of a 1-lb. package of cornstarch (Fig. 6). Mix to a smooth paste. Into this pour sufficient boiling water to make the bucket about three fourths full and stir constantly until the mixture is the consistency of thick cream. Any lumps may be removed by straining through a sieve. Let the paste cool somewhat before using. This amount is sufficient to paper a room of average size.


A drop cloth, an old canvas, or a covering of newspapers will save the floor finish and obviate the necessity of extra cleaning afterward.

Figures 7, 8, and 9 show the three types of seams or joints that may be used—lap, butt, and wire edge. The lap seam, which is most commonly used by amateurs, requires the trimming of one edge only, and several lengths may be trimmed at one time, as in Fig. 10. Some papers are provided with a perforated edge which may be folded back and torn off. Paper thus trimmed is suitable only for a lapped seam.

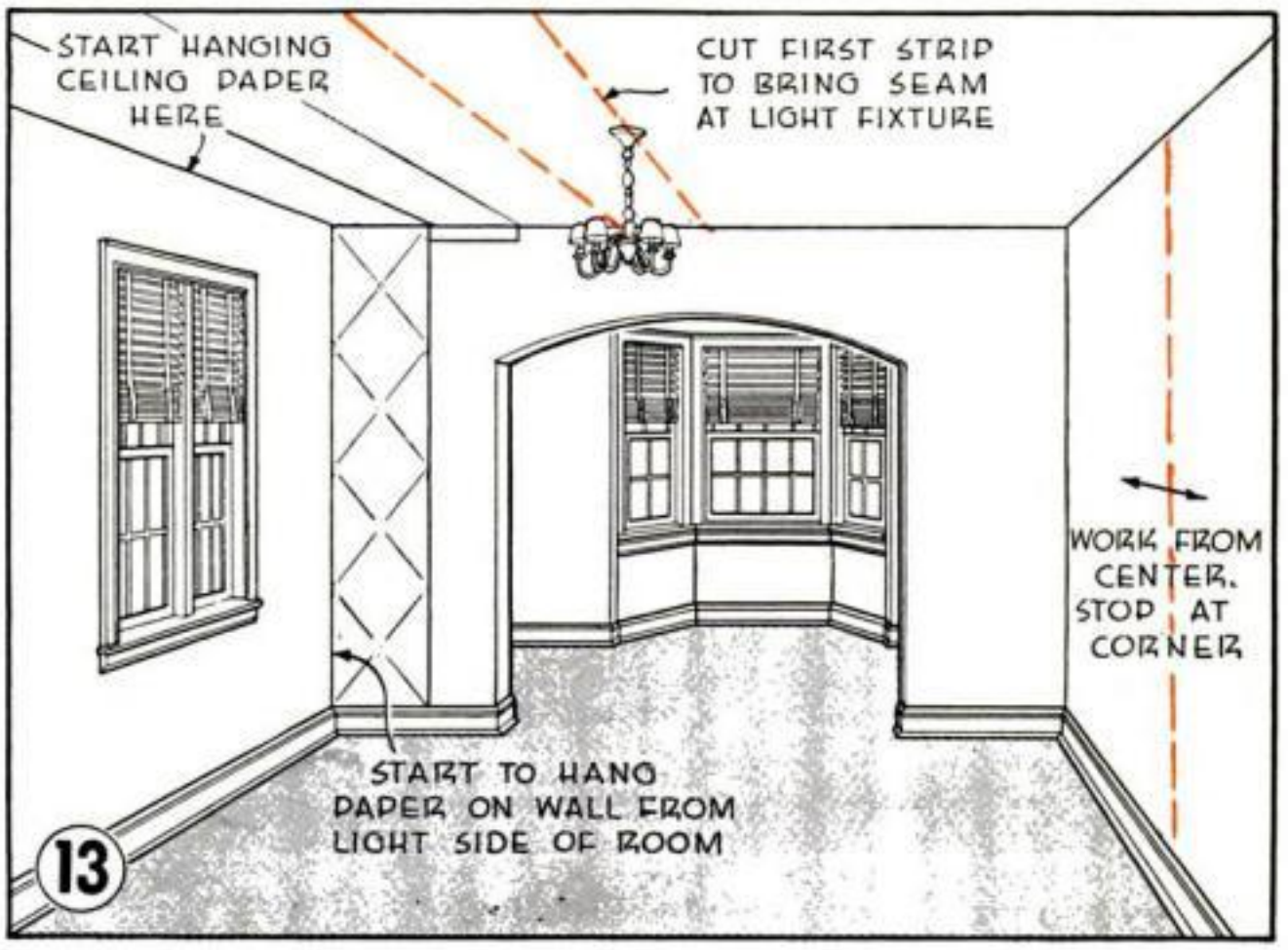
For butt and wire-edge seams, both edges of the paper must be trimmed by hand, one strip at a time, and





greater precision must be exercised in the trimming to obtain a close-fitting seam. Although more skill and patience are required to make the butt type of seam, it gives a neater and more workmanlike job. The seam is visible only upon close inspection.

The wire-edge seam is a modified lap joint, approximately 1/16" lap being used. It requires less skill than does the butt seam to produce a neat joint, but is more difficult to make than the ordinary lap seam.




Papering the ceiling is often regarded by amateurs as the most difficult part of the whole job. However, after a little experience you will find it easier and quicker to do than the side walls because papering the latter involves much careful fitting around doors and windows. The ease with which ceiling papering is done depends largely upon the manner in which the paper is prepared prior to the actual hanging.

Fitting around a ceiling light fixture, however, is an awkward job. If you plan so as to have a seam intersect the fixture as may be seen in Fig. 19, fitting can be avoided and a much neater job results. In order to do this, loosen the fixture shell, then measure from the fixture to the starting point as in Fig. 11. It may be necessary to cut the first strip to bring the seam right to the fixture. Mark the starting point with a chalk line. Simply rub a heavy cord with carpenter's blue chalk, stretch it taut, and snap with the fingers to transfer a chalk line to the ceiling, as in Fig. 12.

If a butt seam is used, it makes little difference whether the strips run the length or the width of the room. With a lap-type seam, it is important to work from the lighted side of the room, as shown in Fig. 13. If this is not done, shadows cast by the overlapping edges make the seams very noticeable.

If the homemade table shown in Fig. 2 is used, the ordinary 18" paper will just cover it, leaving none of the top surface exposed. It will not be necessary to wipe off this table after pasting each strip, as must be done if a wider one is used.

Cut as many strips as will be necessary to

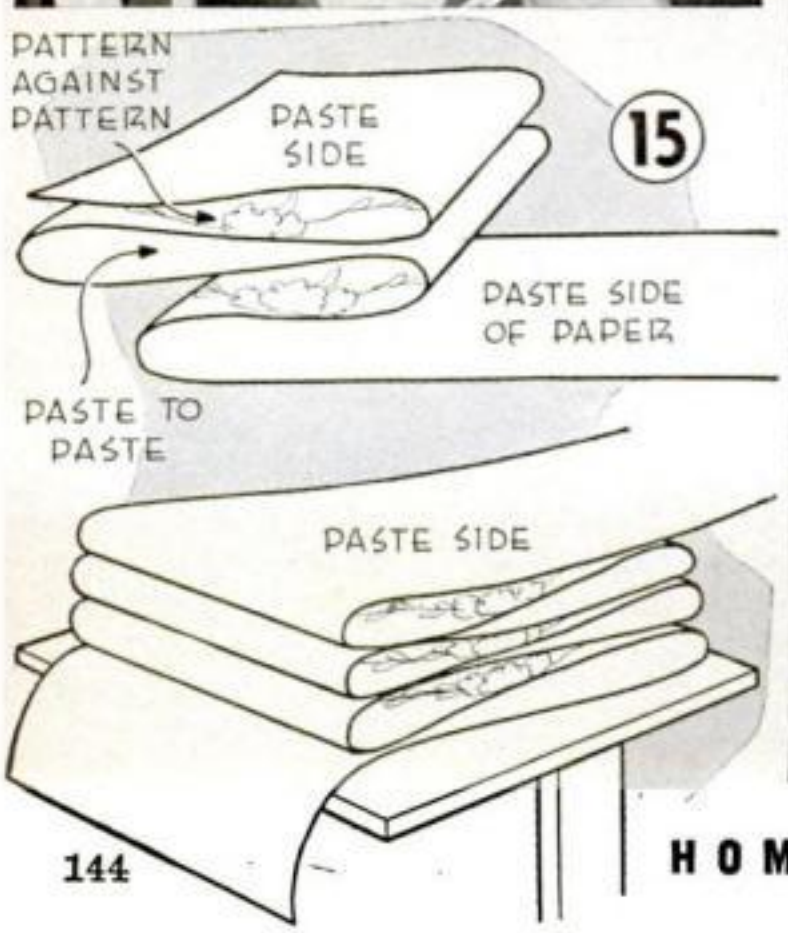
paper the ceiling, making them about 6" longer than the room. Compare all the cut pieces carefully, and if there is any shading off, or difference in tone or color, as sometimes occurs even in the same roll, arrange the strips so that the difference is graduated and therefore minimized, and be careful to hang them in that order. The effect of using a lighter-toned strip between two dark-toned ones may spoil an otherwise perfect piece of work.

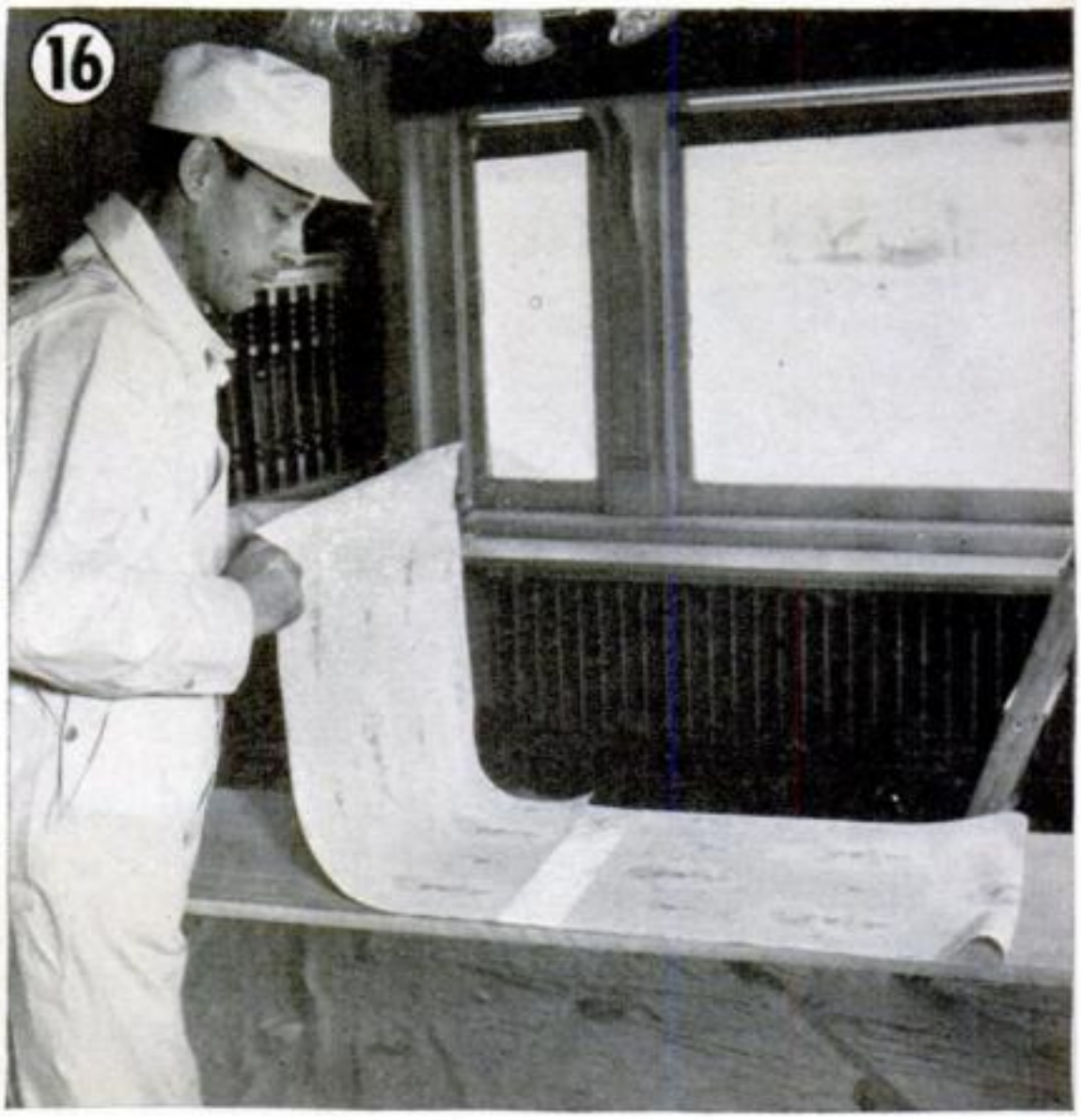
When pasting, draw the brush outward over the edges of the paper as in Fig. 14. Be sure to spread the paste thoroughly and evenly along the edges, but avoid drawing the brush inward against them, for this will result in smearing the pattern side of the paper. Lumps, of course, must be avoided, because they would show badly. If the paste shows any tendency to become lumpy, it should be strained or discarded.

After being pasted, the paper must be folded as in Fig. 15 to facilitate handling. When, however, side-wall paper is pasted, it can be folded by the simpler method shown in Fig. 16. Both ends are folded in towards the center. Figure 18 illustrates an easy and efficient method of holding the pasted paper, and how to start hanging the first strip on the ceiling. Press the end of


## How Many Rolls to Buy

| Size of room (in feet) | Number double rolls side-wall paper needed | | | Length of border in yards | Double rolls of ceiling paper needed |
|---|---|---|---|---|---|
| | Ceiling Height 8' | 9' | 10' | | |
| 8 x 10 | 5 | 5 | 6 | 14 | 2 |
| 10 x 12 | 6 | 6 | 7 | 16 | 2 |
| 10 x 14 | 6 | 7 | 8 | 18 | 3 |
| 12 x 12 | 6 | 7 | 8 | 18 | 3 |
| 12 x 14 | 7 | 8 | 8 | 19 | 3 |
| 12 x 16 | 7 | 8 | 9 | 21 | 4 |
| 14 x 16 | 8 | 9 | 10 | 22 | 4 |
| 14 x 18 | 8 | 9 | 10 | 23 | 4 |
| 15 x 16 | 8 | 9 | 10 | 22 | 4 |
| 15 x 20 | 9 | 10 | 11 | 25 | 5 |
| 16 x 18 | 9 | 10 | 11 | 24 | 5 |



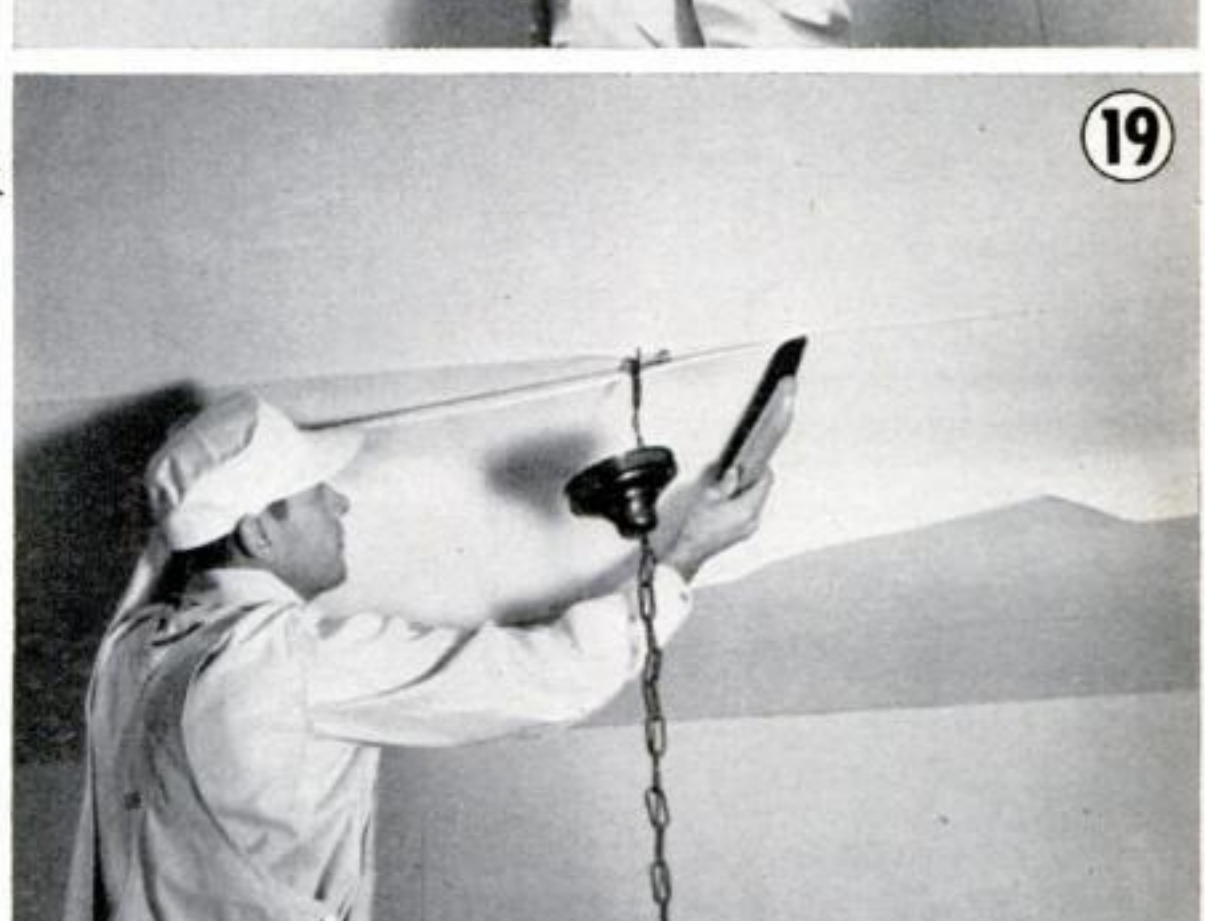
the paper in place with the smoothing brush, allowing it to extend down on the end or side wall 2″ or 3″. As you move across the scaffold, the paper will unfold. Brush it out firmly and smoothly to avoid blisters. Follow the same procedure with succeeding strips (Fig. 19).

A second method of folding ceiling paper, and one which the beginner especially may find helpful, is shown in Fig. 17. The strip is folded accordion fashion, paste to paste, pattern against pattern. A helping stand is required, and can be built from a box and scrap lumber as shown. The folded strip is placed upon the stand, and the end pasted up. As the strip is applied, the stand must be moved along the scaffold, and the paper opens fold by fold.

It is a good rule to hang four or five strips before rolling the seams. This allows the wall surface and the paper to absorb paste, lessening the possibility that the latter will be squeezed through at the joint and stain the pattern. Always take care to press the paper into corners and ends.

In case future patching may be necessary, it is a good idea to tack up a left-over strip of paper—particularly that for the side walls—somewhere in an attic or storeroom, where it will age naturally. Repairs taken from such a strip will match better than those cut from a rolled-up remnant.

(TO BE CONCLUDED)

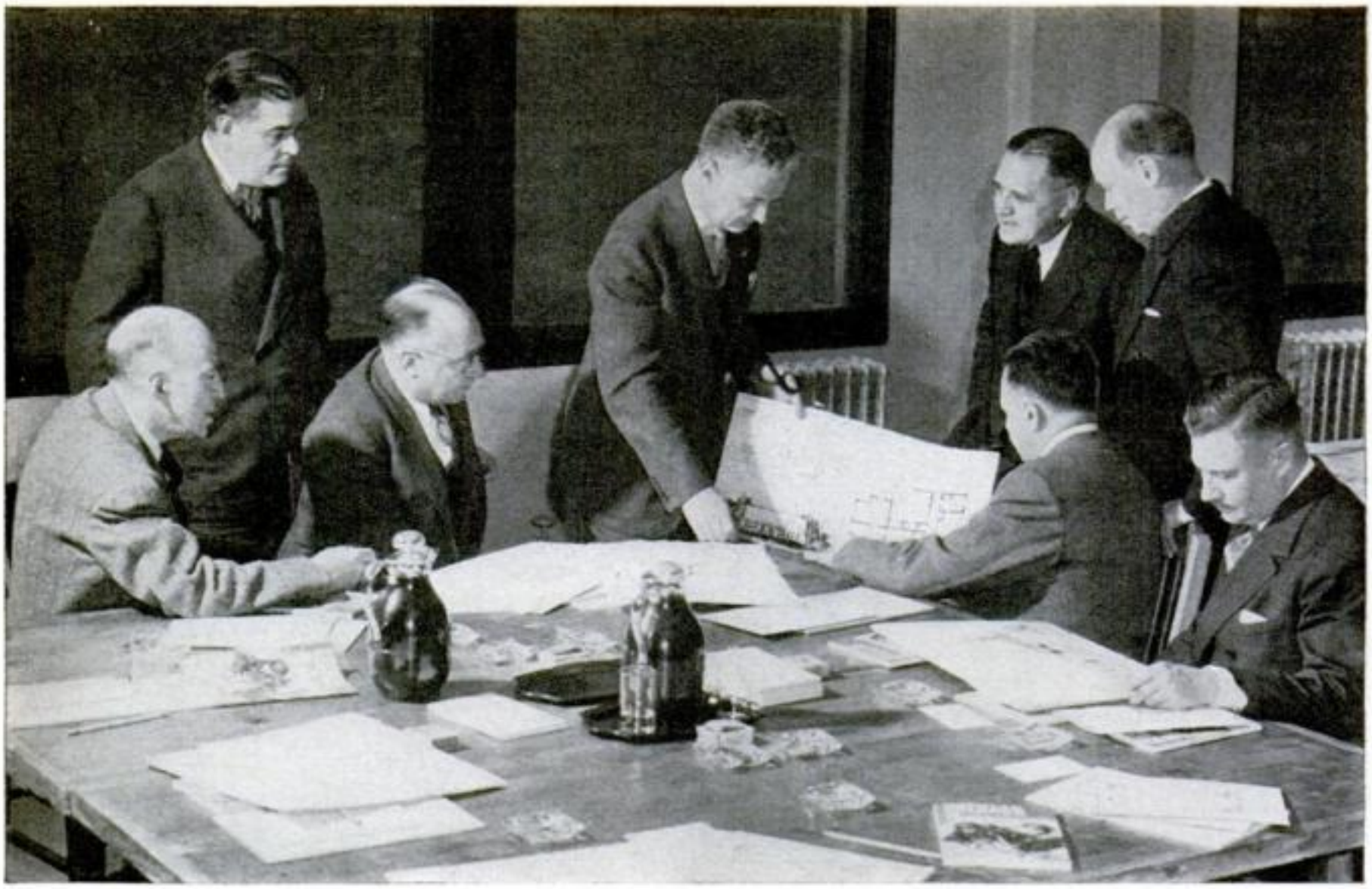


18



19


17



Seated, left to right, H. H. Saylor, Cameron Clark, Ely Jacques Kahn, Greville Rickard; standing, Charles McLendon, F. J. Woodbridge, Godfrey Hammond, publisher of POPULAR SCIENCE, and Arthur Wakeling

$1000 CONTEST

# Judges Face Huge Task in House-Planning Contest

IF WE had had any doubts that our readers were thinking of building new homes, those doubts would have been swept out of the office by the 3,307 entries received in our $1,000 house-planning contest.

As we go to press with this issue, the judges are busy with their painstaking task of selecting the thirty prize winners. This work is being done by the following eminent architects, together with Charles McLendon, editor-in-chief of POPULAR SCIENCE, and Arthur Wakeling, home and workshop editor:

CAMERON CLARK, who has achieved a nation-wide reputation for his design of houses, schools, and other community structures that reflect the best traditions of early American building.

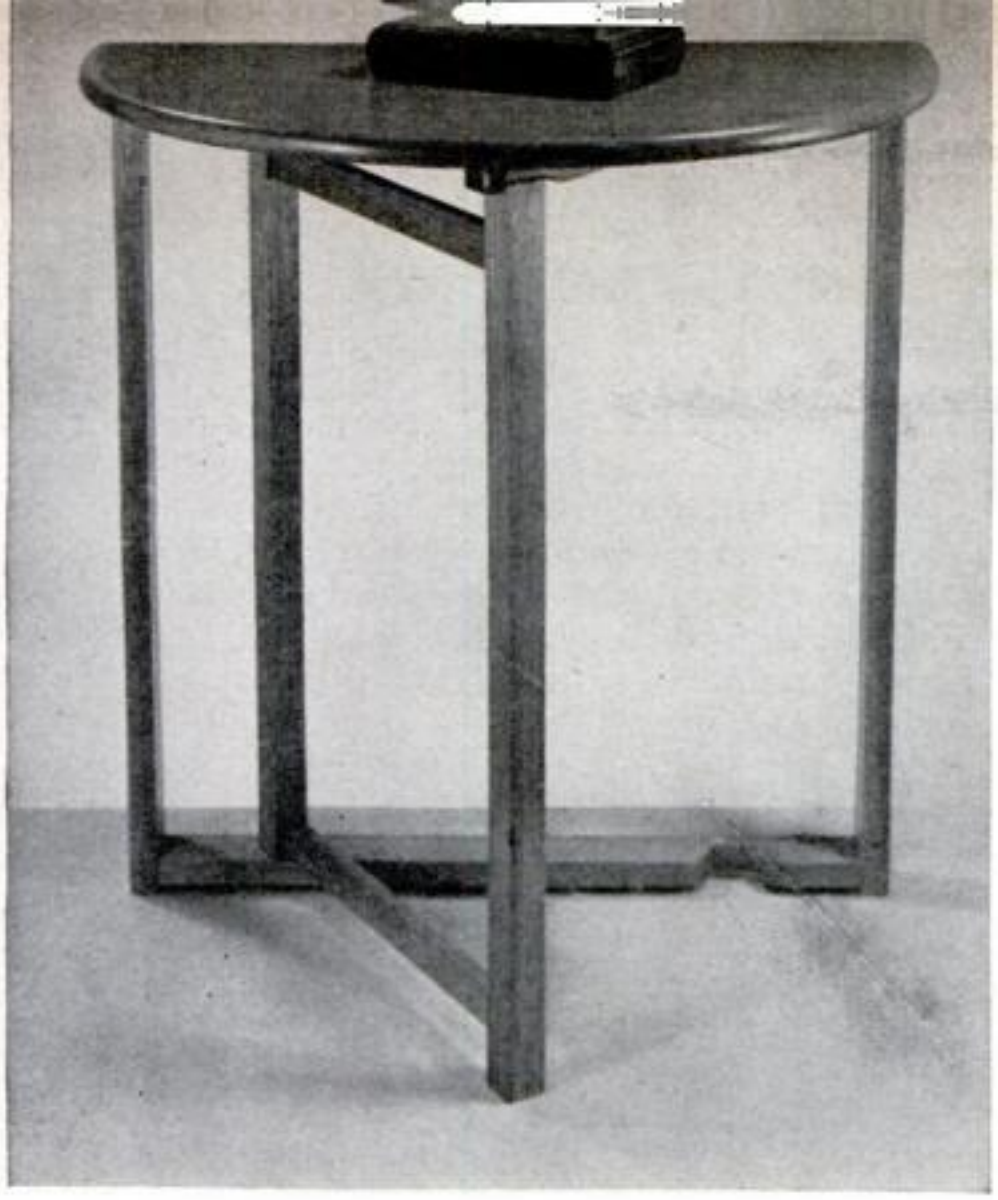
ELY JACQUES KAHN, who has designed many New York skyscrapers and who takes no less pride in the creation of a small house. The Metropolitan Museum of Art selected Mr. Kahn to coördinate the efforts of some 600 other designers with his own in creating the 1940 Exhibition of Contemporary American Industrial Art. He has served as Director of Architecture of the Beaux-Arts Institute of Design and was recently appointed special consultant in the Government's work of providing recreation facilities at Army camps.

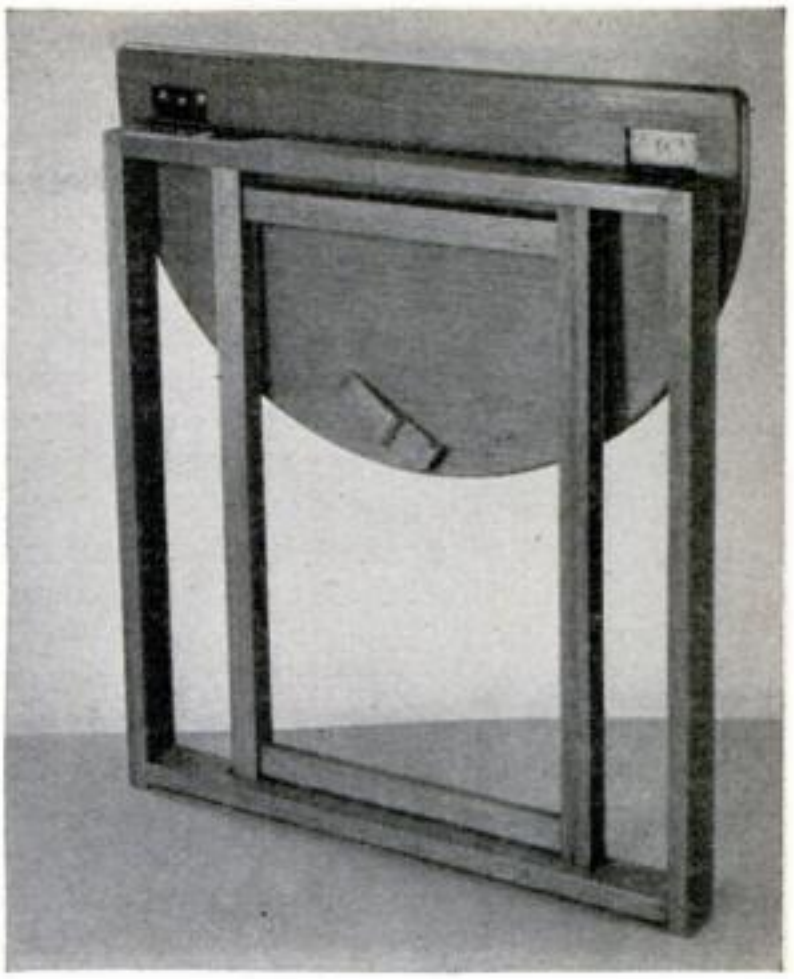
FREDERICK J. WOODBRIDGE, of Evans, Moore & Woodbridge, who was recently elected president of The Architectural League of New York. His firm has designed many houses. Mr. Woodbridge extends his busy days of practice by teaching in evening classes of Columbia University's Architectural School.

Acting as technical adviser in questions relating to procedure is Henry H. Saylor, a registered architect in New York and New Jersey, author of various books and magazine articles on architectural subjects, and member of a committee on competitions of the American Institute of Architects.

Greville Rickard, a New York architect with many outstanding and prize-winning house designs to his credit, is architectural consultant for POPULAR SCIENCE.

It is expected that the jury will have completed its findings in time for a full announcement in our October issue.





Closed, this end table is only two inches thick. Several could be stored in even a shallow closet. The top has enough spring to let the gate leg snap into the catch

# Fold-Away End Table

## DESIGNED BY JOSEPH ARONSON

END TABLES are sometimes too much with us in the average room. We can, however, enjoy their convenience or dispense with them at will if they are of the folding type shown here.

When the gate is open, it locks into a homemade wooden catch. The hinges are recessed into the underside of the top. Dowels are used at all the joints. The gate may, in fact, be made with legs of ⅞" dowels instead of with the square ones shown. When closed, the swinging leg fits into notches cut into the top and bottom crosspieces. Pivot the gate on two 2" wood screws.

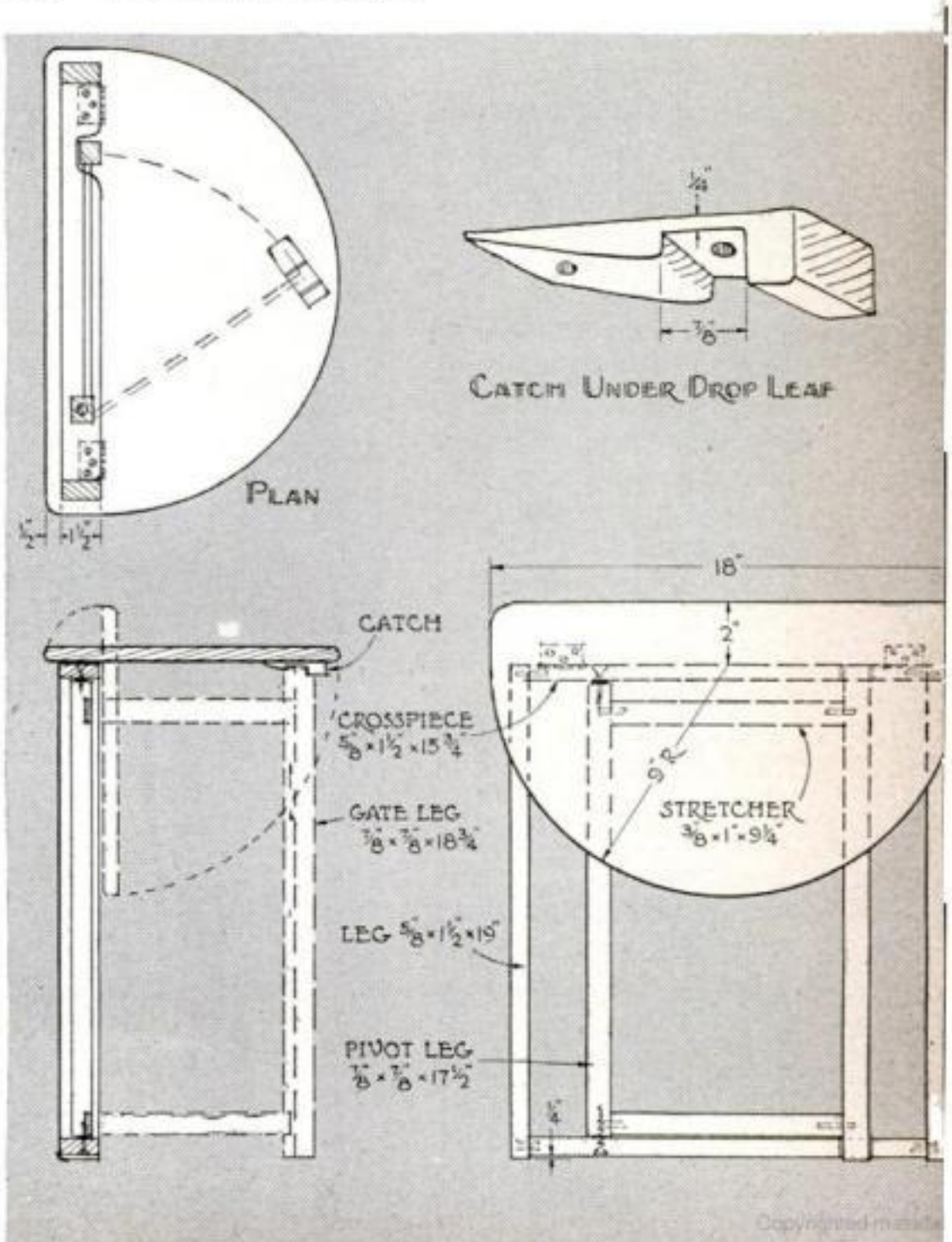
If nicely figured wood is not available, you can use any firmly grained stock and paint the tables in solid colors to suit any decorative scheme.

### MATERIALS

| No. Pc. | Description | T. | W. | L. |
|---|---|---|---|---|
| 1 | Top | ⅝ | 11 | 18 |
| 2 | Legs | ⅝ | 1½ | 19 |
| 2 | Crosspieces | ⅝ | 1½ | 15¾ |
| 1 | Pivot leg | ⅞ | ⅞ | 17½ |
| 1 | Gate leg | ⅞ | ⅞ | 18¾ |
| 2 | Stretchers | ⅜ | 1 | 9¼ |
| 1 | Stop | ⅞ | ⅝ | 3 |

Hardware: One pair broad butt hinges 2" by 2" with screws, and two 2" screws and washers.

**Note:** All dimensions are given in inches and are finished sizes.



# White-Pine Buffet

## COPIED FROM A PENNSYLVANIA WATER BENCH

**By JOSEPH ARONSON**
*Author of The Encyclopedia of Furniture*

AMONG the Pennsylvania Dutch one frequently finds a piece of furniture called a *Wasserhulch* by those industrious people. The design is characteristically honest and directly suited to its purpose, which seems chiefly to have been to hold pans of water for the farmer's ablutions before meals.

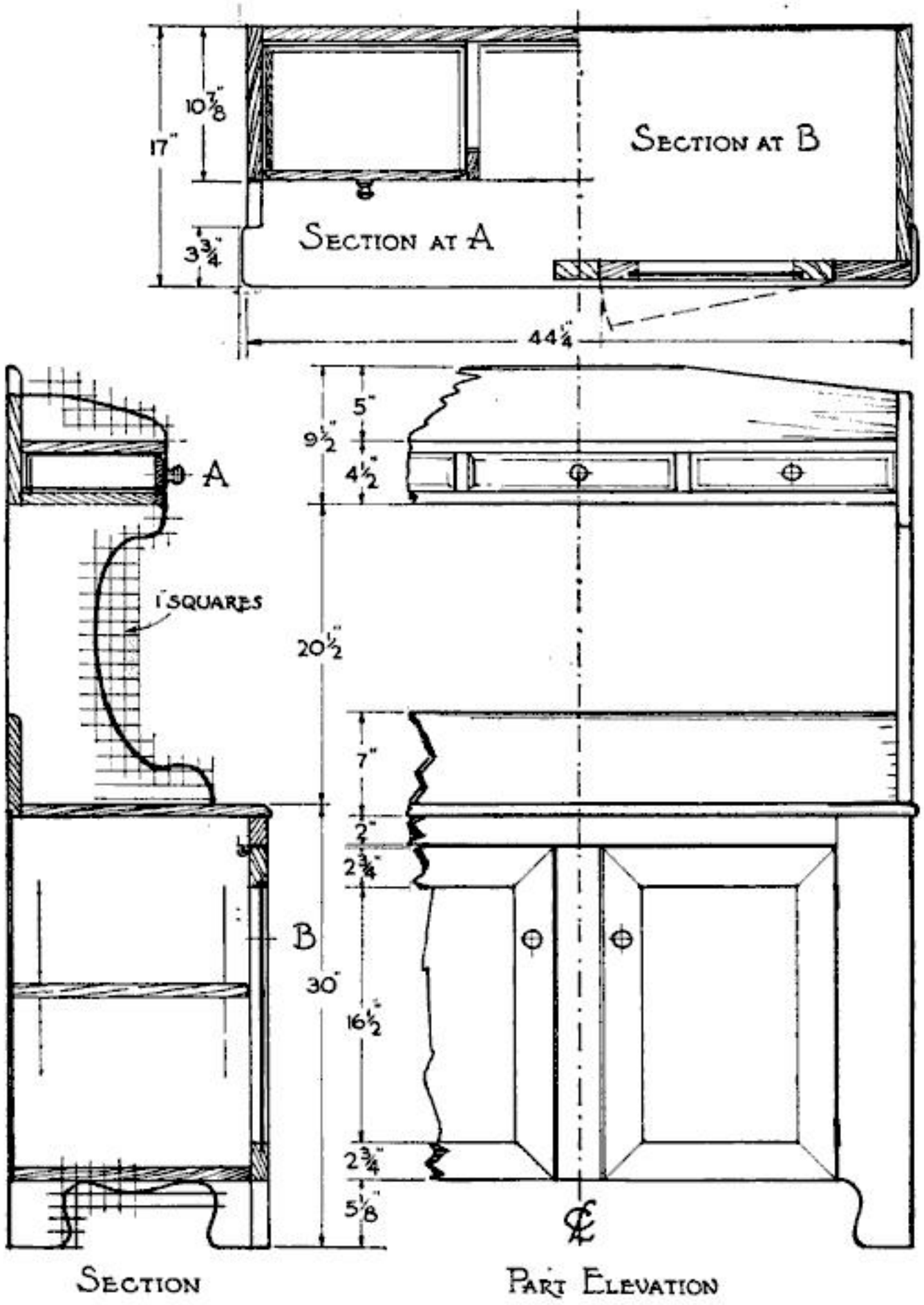
Collectors of antiques eagerly seek out and often pay considerable prices for these simple cabinets, because of their honest workmanship, good proportions, and pleasing patina. In fact, many of these utilitarian pieces wind up a century or more of usefulness by becoming an admired buffet or living-room cabinet in homes where the furnishings emphasize the beauty of good American craftsmanship.

The copy shown in the photograph was made from start to finish in about 24 working hours. Ordinary shop pine was used. The stock was selected only for freedom from coarse grain or bad knots. Sound knots will be found to add to, rather than detract from, the attractiveness of the piece. Cabinets of this design are often found as long as 50", but for average purposes the dimensions shown afford very satisfactory proportions.

Band-saw out the sides and front posts and glue them together with the flush joints coming on the sides. Assemble the parts forming the top case in which the drawers fit. Dowel and glue all the cross members to the sides —floor, counter top, back rails, and, of course, the drawer case.

The drawers are put together with a simple dado joint ¼" deep, and are beveled around the face ½" by ⅛". The drawer bottoms are dadoed into the fronts and sides, but extend beyond the backs. The doors are mitered together around ¼" plywood panels, which are dadoed in with ¼" sinkage, although the more correct traditional method would be to use a ⅞" thick beveled solid panel, framed in without glue. All the edges should be sanded quite round to avoid a too mechanical regularity. As the shelf lies upon removable pins, it may be moved to various heights above the floor.

The copy was stained with Vandyke brown in oil, given two very thin coats of shellac, sanded down, and thoroughly waxed.



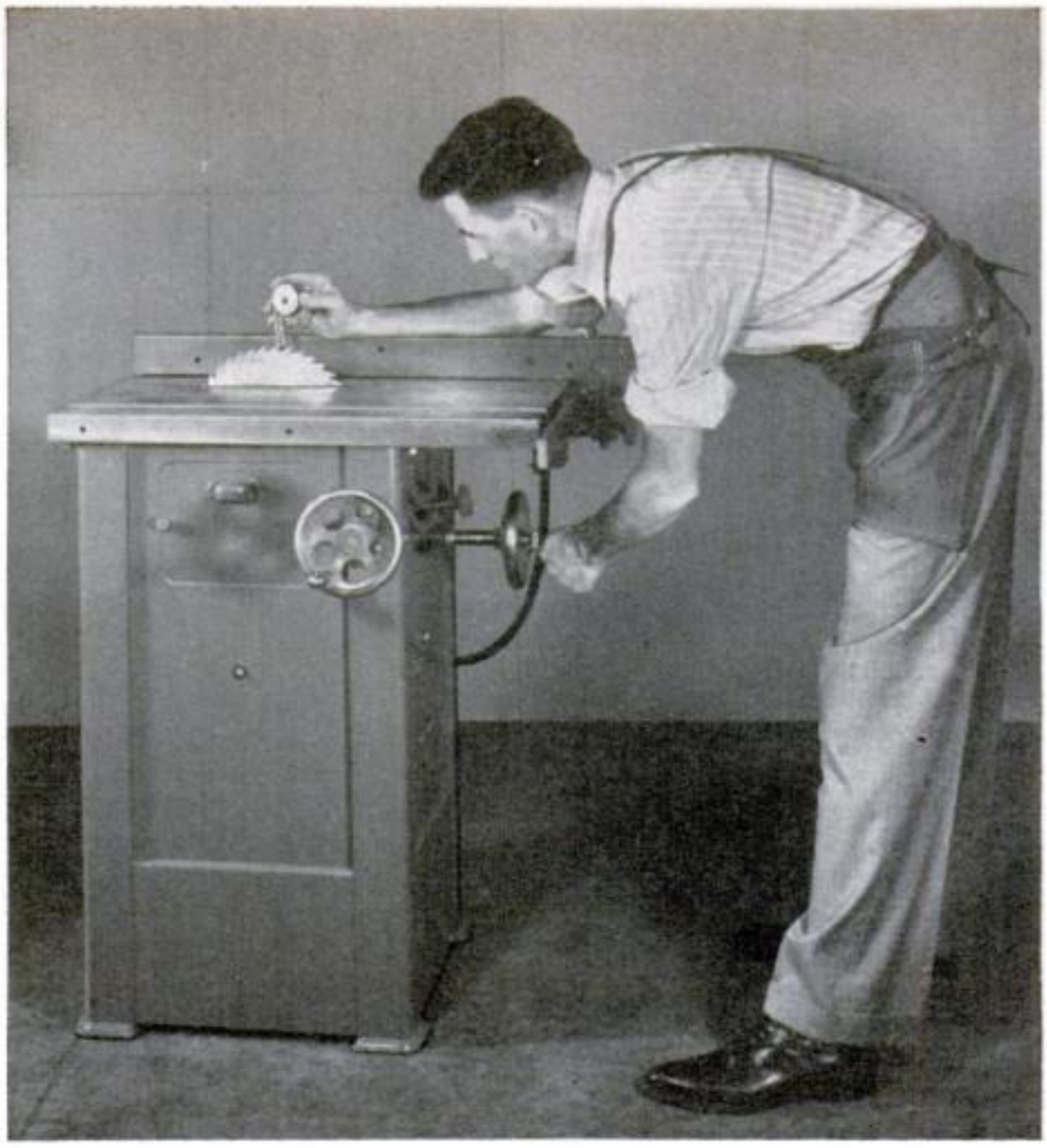

## MATERIALS

| No. Pc. | Description | T. | W. | L. |
|---|---|---|---|---|
| 2 | Sides | ⅞ | 15⅞ | 58 |
| 1 | Top rail | ⅞ | 9½ | 42½ |
| 1 | Top shelf | ⅞ | 10 | 42½ |
| 1 | Drawer shelf | ⅞ | 10 | 42½ |
| 2 | Drawer separators | ⅞ | 1¾ | 2¾ |
| 2 | Drawer guides | ⅞ | ⅞ | 8 |
| 3 | Drawer fronts | ⅝ | 2¾ | 13⅝ |
| 6 | Drawer sides | ½ | 2¾ | 9½ |
| 3 | Drawer backs | ½ | 2¼ | 13 |
| 3 | Drawer bottoms (plywood) | ¼ | 9½ | 13 |
| 1 | Counter top | ⅞ | 16¾ | 44½ |
| 1 | Back rail | ⅞ | 7 | 42½ |
| 1 | Back panel (plywood) | ¼ | 24½ | 43¼ |
| 1 | Floor | ⅞ | 15⅝ | 42½ |
| 1 | Shelf | ⅞ | 15⅝ | 42½ |
| 2 | Front posts | 1⅛ | 5½ | 29⅛ |
| 1 | Top front rail | 1⅛ | 2 | 33¼ |
| 1 | Mullion | 1⅛ | 3 | 22 |
| 4 | Door stiles | 1⅛ | 2¾ | 22 |
| 4 | Door rails | 1⅛ | 2¾ | 15 |
| 2 | Door panels (plywood) | ¼ | 10 | 17 |

Hardware: Two cupboard catches, four broad brass butts 2" by 2", five hardwood knobs, and four shelf pins.

**Note:** All dimensions are given in inches and are finished sizes.

To adjust depth of cut or to set the depth gauge, measure from the table to the tip of the uppermost tooth. Various types of table inserts are shown at bottom of this page



# HOW TO SET UP AND ADJUST A Circular Saw

By
**EDWIN M. LOVE**

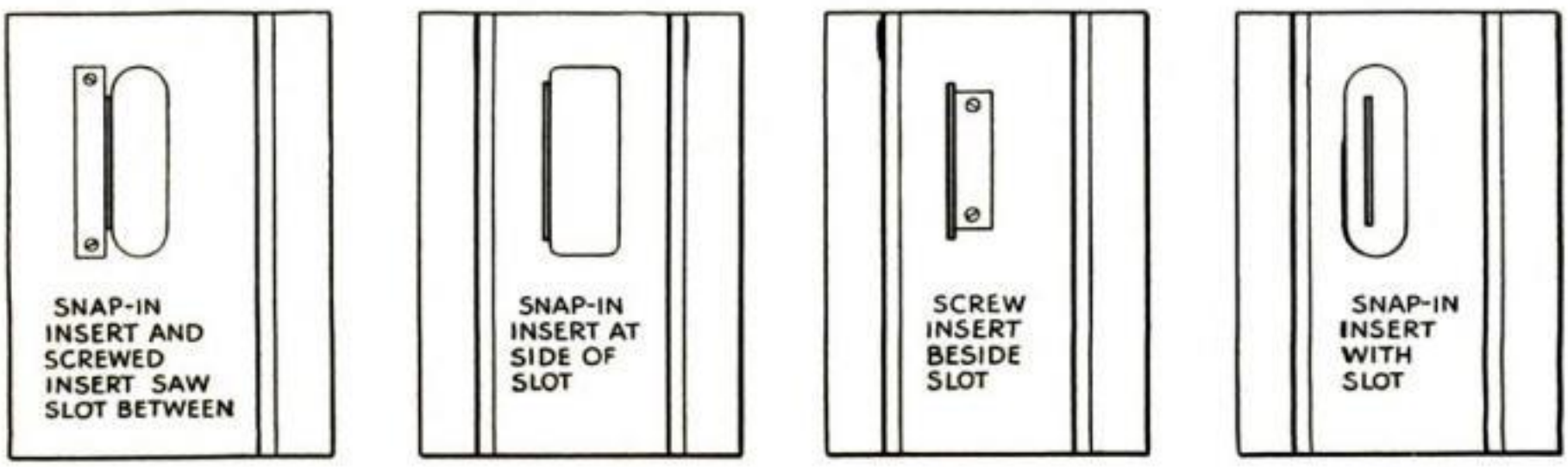
THE THRILL that the home shop mechanic experiences when the crates containing his new circular saw and motor are placed on his shop floor is second only to that of trying the saw out for the first time. Before the machine can be used, however, it must be unpacked and mounted.

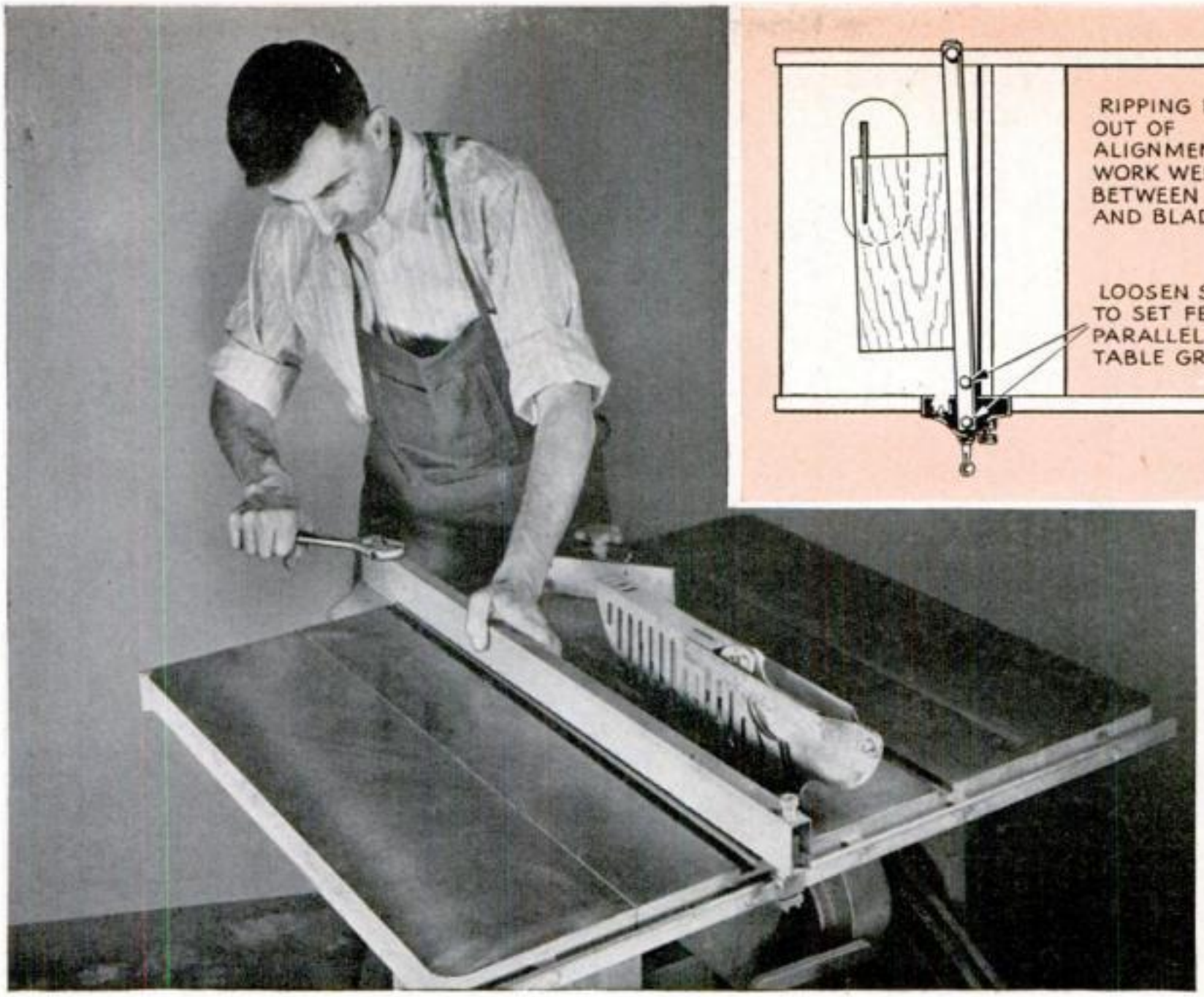
### *How should the saw be unpacked?*

CLIP the binding wires or metal strips and carefully pry off the boards from the top. Take care that the tool used does not slip inside and scratch the machine. Remove the wads of paper packing, opening each to make certain that no small parts, mounting bolts, or washers, are wrapped in it, before throwing it away. When the machine has been uncovered, it will be easy to see how the hold-down blocks that secure it to the crate should be removed.

### *How is the saw set up?*

A PRINTED folder giving full directions is supplied with every circular saw, and should be studied carefully. Be sure that the motor turns in the right direction. If it does not, and is of the type in which the shaft projects at both ends, turn it end for end and change the pulley accordingly. If the motor shaft projects at one end only, it may be necessary to reverse its rotation by changing connections according to the instruction sheet furnished with the motor.







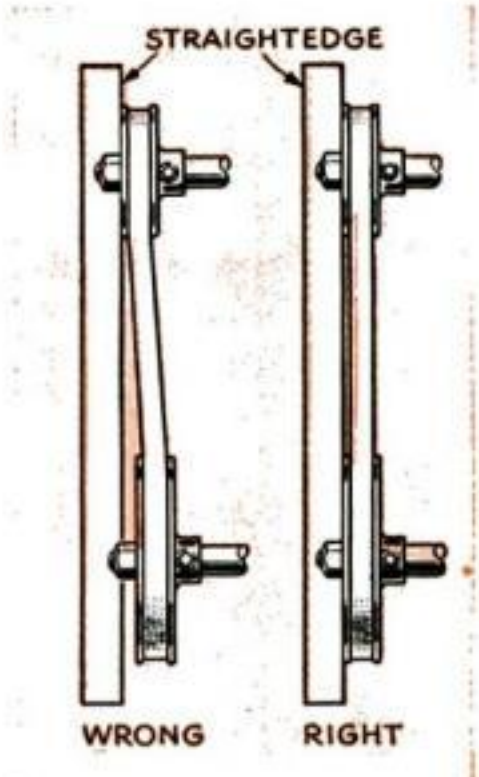

Adjust the ripping fence by aligning it with a table groove, which must itself be parallel to the blade

### *What kind of stand should the saw be mounted on?*

IT CAN be mounted on a bench, or on a separate stand of steel or wood, which is generally preferable. There must be provision for cleaning out sawdust from beneath the machine.

### *What type of blade is furnished?*

THE saw is usually equipped by the manufacturer with a combination blade. Its diameter is that by which the saw is listed for size, such as 8", 10", and so on. This blade is for ripping (cutting lengthwise of the grain) and crosscutting (cutting across the grain). It will not rip quite as fast as a rip saw, nor crosscut as fast as a crosscut blade. However, the home mechanic shifts from one operation to the other so often that it would be a bother to change blades.




To prevent undue wear on drive belts, check alignment of pulleys by means of a simple straightedge

### *How should a circular saw blade be mounted on the arbor?*

REMOVE the soft-metal insert in the center of the table. On some varieties of saws it may be necessary to remove one or two screws before the insert can be lifted out. Take off the arbor nut, remembering that it is probably a *left-handed* nut, and the washer as well.

Slip on the blade with the rake of the teeth pointing in the direction of rotation, turn it so that the name of the maker is at the top, and tighten the nut. The hole is necessarily a little larger than the arbor, and the blade will therefore rest upon the upper side of the arbor, and not quite touch the lower side. If the blade is always mounted in this way, that is, with the maker's name topmost when putting on the arbor nut, the teeth will track in a circle that centers on the shaft. After mounting the blade,

Properly adjusted stops facilitate resetting the crosscut gauge quickly for square or miter cuts

A try-square or bevel protractor may be used to set the gauge. Check setting by making trial cuts

replace the insert and turn the arbor by hand to see that the teeth clear.

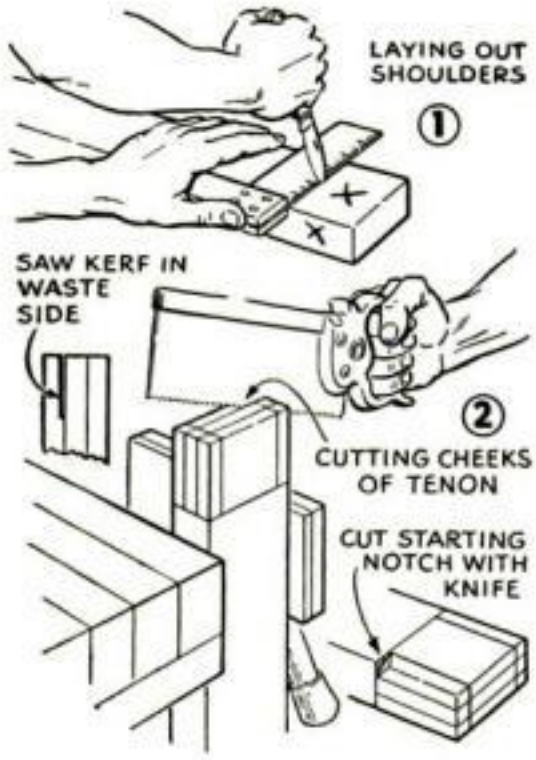
### *How is the projection of the blade above the table regulated?*

BY RAISING and lowering either the arbor or the table, according to the design of the machine. There will be a crank, wheel, or lever on the front of the saw which may be turned or lifted to adjust the blade for the required depth of cut.

### *How is the arbor alignment checked?*

THE grooves in the table must be parallel to the blade. Measure the distance from one groove to a tooth at the front of the saw slot, then turn this tooth to the back, and measure from it to the groove again. If

## CUTTING A TENON BY HAND [*WOODWORKING*]




1. Square shoulder lines around the piece, pressing the try-square against the face side and edge. Use a sharply pointed hard pencil, or, better still, the point of a knife. 2. Gauge the thickness of the tenon on edges and end, working from the face side; also the width, working from the face edge. The thickness is usually one third that of the stock. 3. Rip the cheeks, splitting the line but with the kerf in the waste wood. 4. Rip to width. 5. Saw the side shoulders. Starting is made easier by chiseling a notch. 6. Cut the edge shoulders.

POPULAR SCIENCE MONTHLY SHOP DATA FILE

measurements are made from different teeth, without turning the blade, differences in the amount of set or other irregularities may cause error. If the arbor is out of true, loosen the screws that hold the table and tap the edge with a mallet to shift the table as necessary. Then tighten the screws again. Be sure that there is proper clearance between the blade and the slotted insert.

### *How is the ripping fence tested for alignment?*

MOVE the fence until its front end is flush with one side of a table groove, and lock it. If it slants to one side or the other, loosen the screws holding the bar and shift the latter until it is parallel with the groove. Then move the fence until it lightly touches the blade, and set the calibration pointer to zero. This setting is correct for the blade on the arbor, but not necessarily correct for other blades.

### *How is the crosscut gauge adjusted?*

THE front edge of the table on most saws is square with the grooves. Put the gauge upside down in the groove, push the head against the table edge and lock it, or use a try-square, as in one of the photographs. Angular settings are made by using a bevel protractor, or the calibrated scale on the head. For accurate angular cuts, make trial cuts in waste wood, and adjust the gauge to suit.

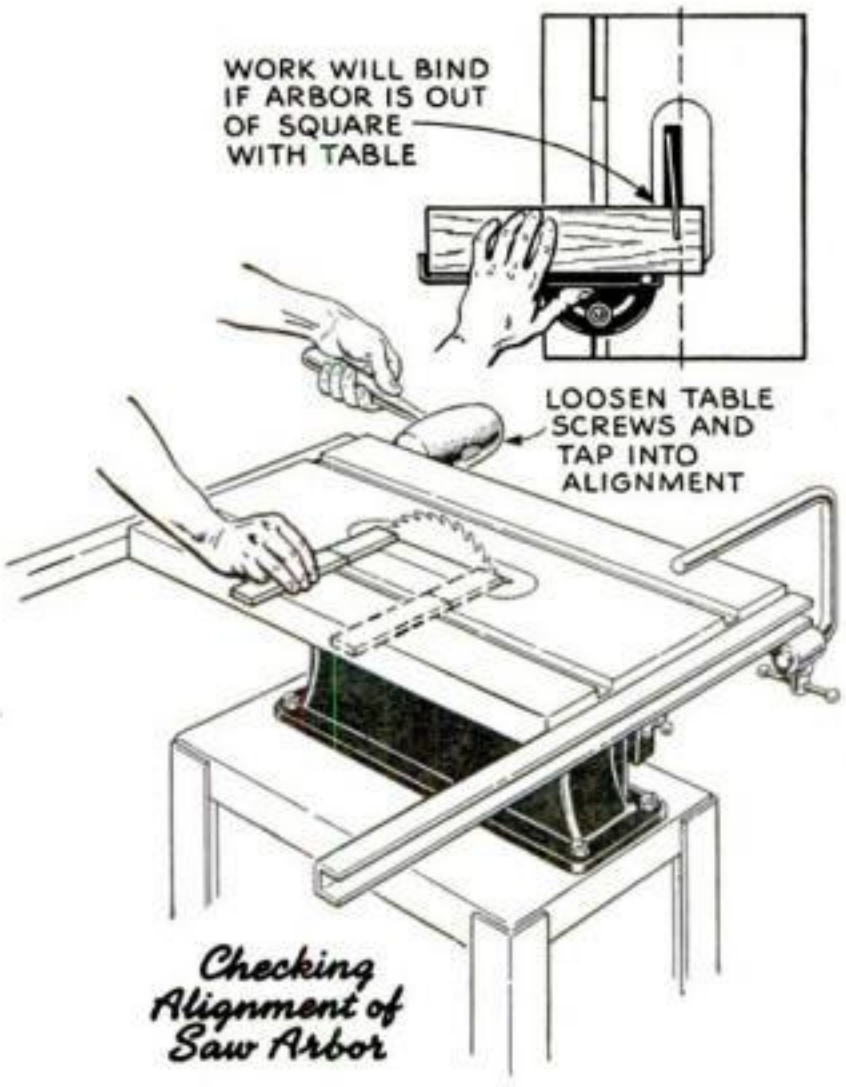
Many gauges have stop screws at the square and miter (45-deg.) positions, which should be adjusted by trial cuts. Such stops allow the head to be set quickly and accurately at any of the three positions without making test cuts repeatedly.

### *How should the first tryout cuts be made with the saw?*

SET the ripping fence to the width of cut desired, raise the blade or lower the table until the teeth project about ⅛" above the thickness of the board, and lock in this position. Lay a board on the table, with a straightedge against the fence, and push it forward with an even motion. If the blade is in good condition, it should cut a board 2' long without binding. If it binds, either the arbor is out of alignment with the table, or, more likely, the fence is not parallel to the blade. Check as explained previously and make another trial cut.

Clamp a short piece of stock to the crosscut gauge, or use the length stop to prevent it from shifting. Cut off the end of the piece. If it binds at the back of the saw the arbor is not square with the table grooves.

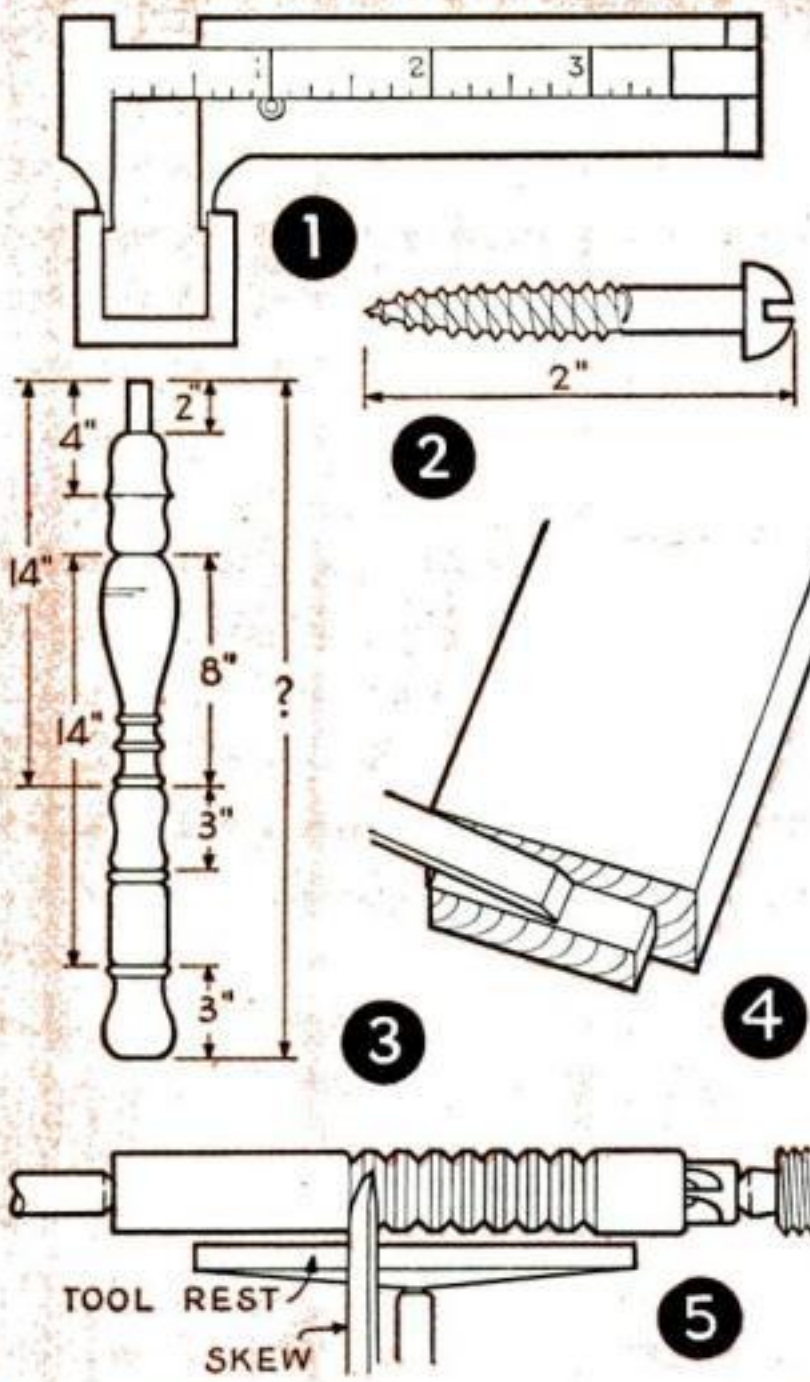
(TO BE CONTINUED)




*Checking Alignment of Saw Arbor*

Use the crosscut gauge with its stop rod to check alignment of the saw arbor. If out of square, align as shown at left

# What's Wrong IN THESE SKETCHES?




SEE if you can catch the errors that have been purposely made in the five drawings at left. The first illustrates a piece of work being calipered to find the inside diameter. The second shows an ordinary roundhead screw. In the third, what is the missing dimension? In the fourth sketch, a chisel is being used to smooth up the cheek of a tenon. The fifth is a view of a spindle turning in which V's are being cut. You will find the answers below, printed upside down.

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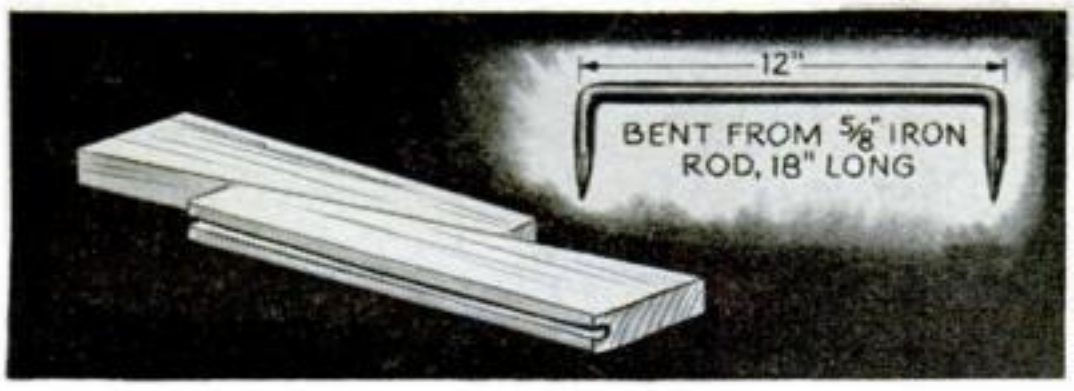
1. There is no inside reference mark on the inner jaw of the calipers by which to determine inside measurements. As shown, the calipers can be used only for outside measurements. 2. The length of roundhead screws is measured from the base of the head to the point. 3. The total length of the turning is 23". 4. For this work, a chisel should not be used at an angle, but parallel with the direction of the cut. 5. The chisel rest should be on the opposite side of the turning, as the live or driving center is always at the left.

## Staple Bent from Heavy Rod Aids in Laying Warped Tongue-and-Groove Flooring

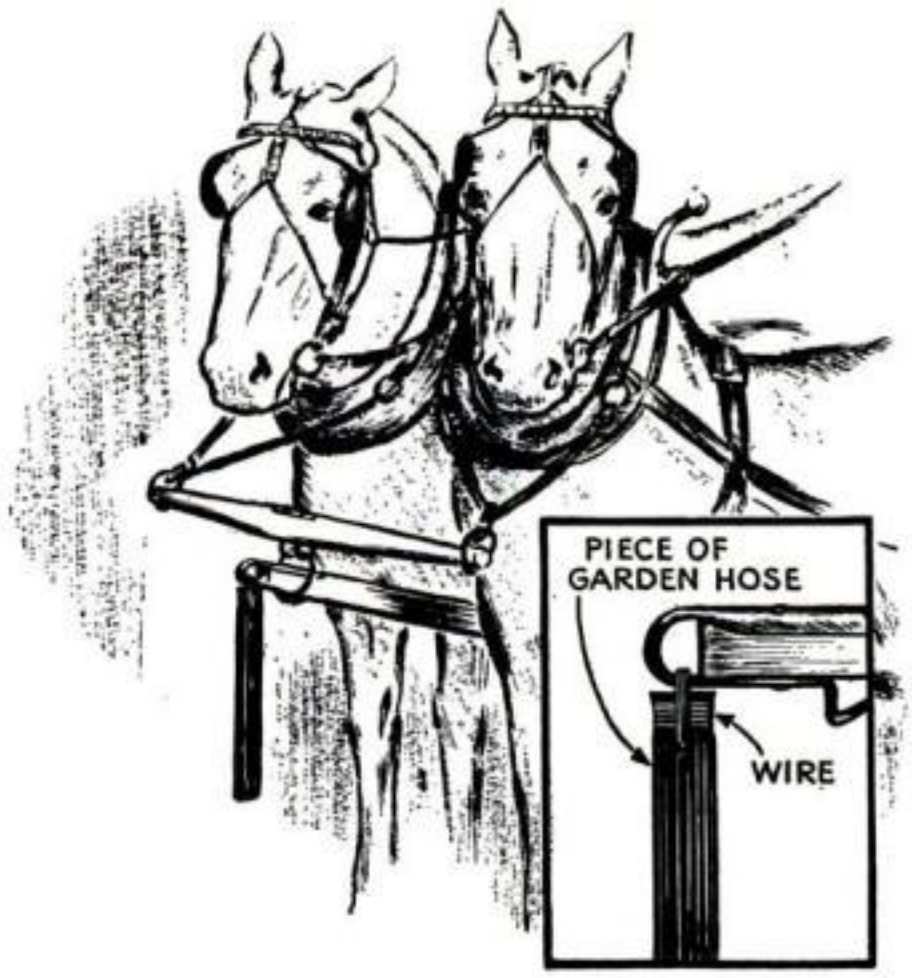
WHEN the proper facilities are not at hand for laying tongue-and-groove flooring, some sort of wedging method is frequently used to set the pieces up tight. These wedges can be held with a double-pointed iron rod as shown. If a few holes in the joists or rough flooring are not objected to, the most obstinate piece of flooring can be forced into place. The groove is left on one of the wedges, which are cut from a scrap of flooring.—R. S. MACNEILL.

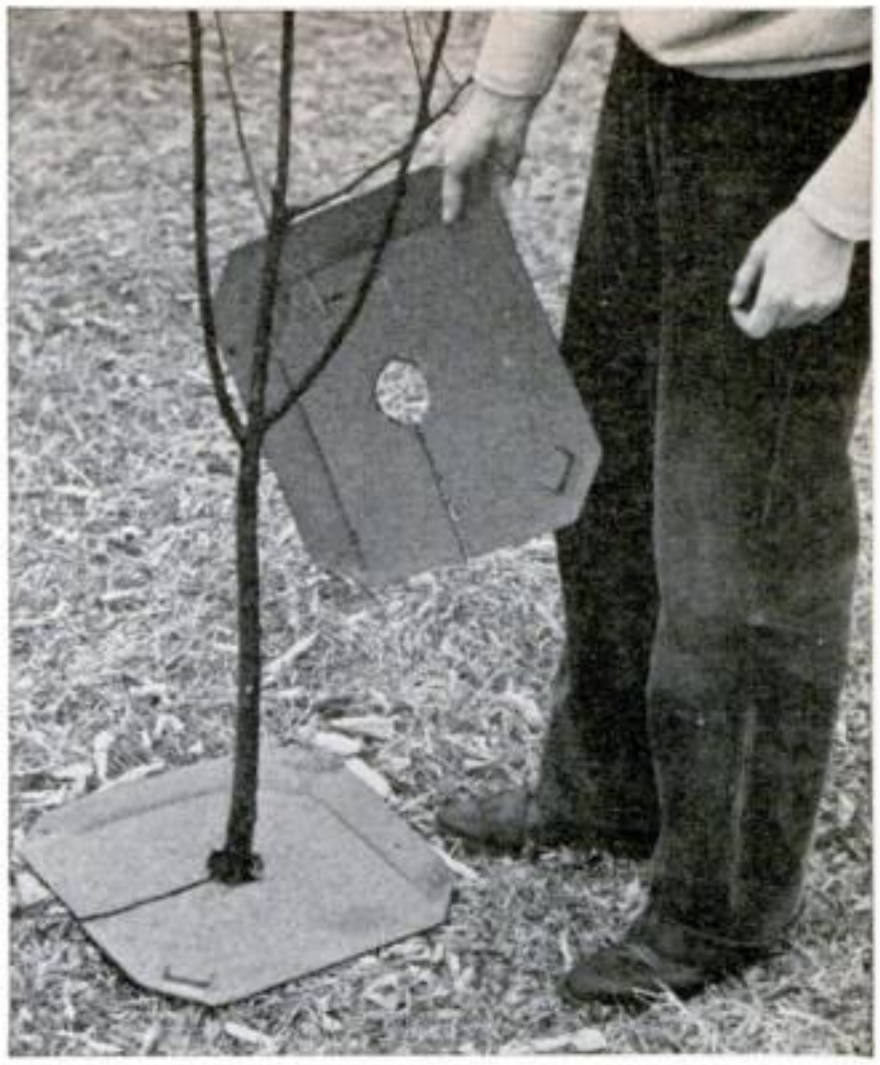



The staple is driven temporarily into the rough flooring or joists to give a firm bearing for a pair of wedges

## Length of Hose Keeps Reins from Under Wagon Tongue

INSIDE reins on team harness that persist in getting under the wagon tongue can be kept in place by an 18" length of old garden hose fastened to the loop on the end of the tongue. A couple of holes punched in one end of the hose and a foot of wire do the trick.—LOWELL MASDEN.



## Mulching Collars for Trees

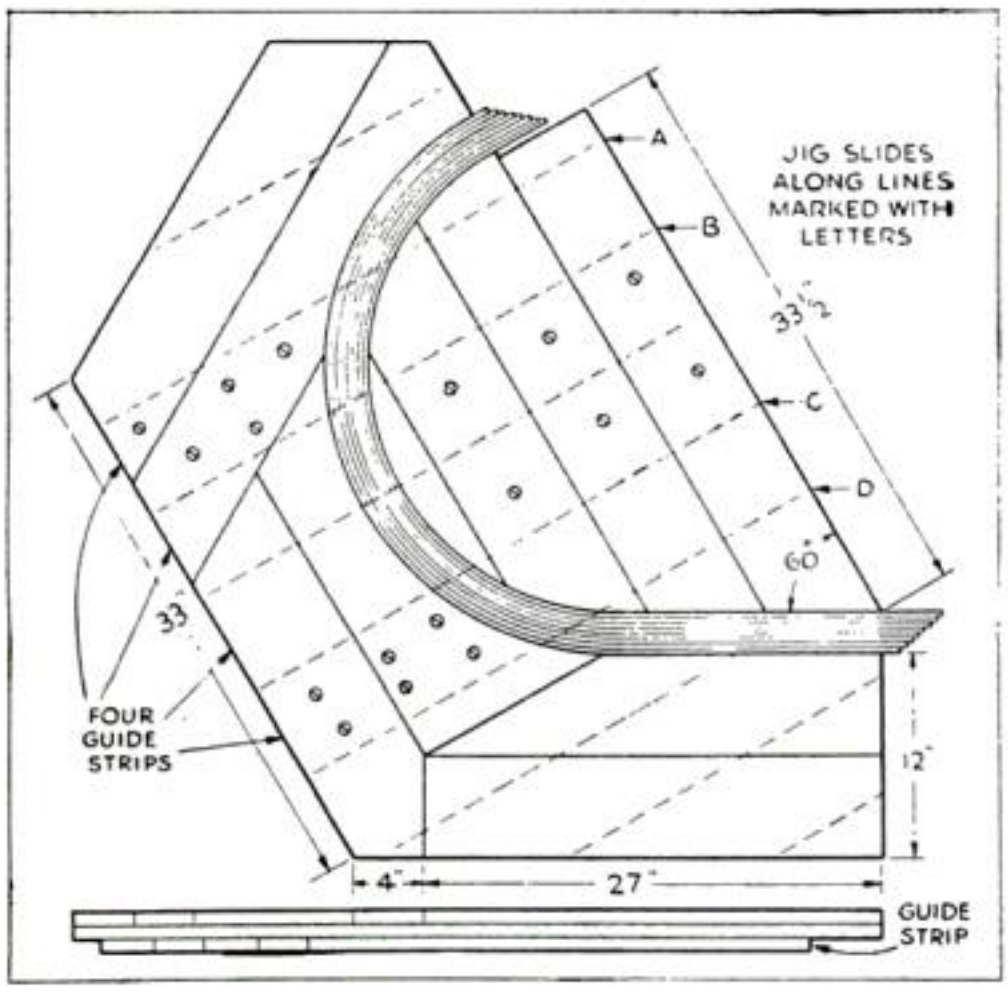
DISCARDED asphalt shingles or 15" to 18" square pieces cut from old composition roofing make mulching collars for newly planted trees, holding moisture about the roots. They should be removed in from six weeks to three months.—S. Y. CALDWELL.

## Scraper of Channel Iron Clears Woodland Paths and Roads

BUILDING woodland paths and roads is made easier with a length of channel iron bolted at an angle on the bottom of a tractor-drawn stone boat to tear out brush and roots. Shim up the iron, if small, to make it cut deeper. In the same operation, clumps of sod can be broken up and the path leveled by dragging a harrow behind.

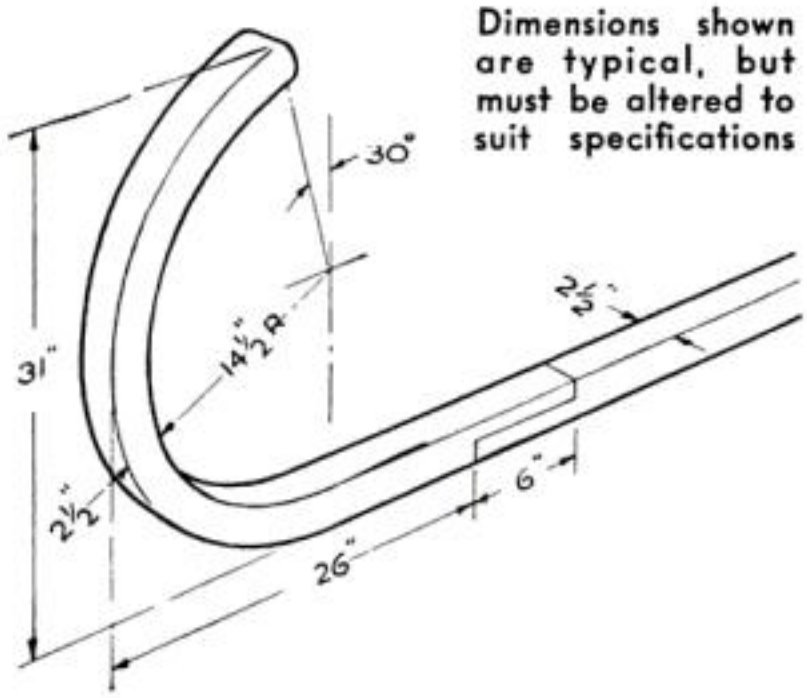
The up-ended "boat" at right gives a view of the channel-iron scraper. Left, a harrow does the leveling

# Laminated Construction Simplifies Building of Canoe Ends

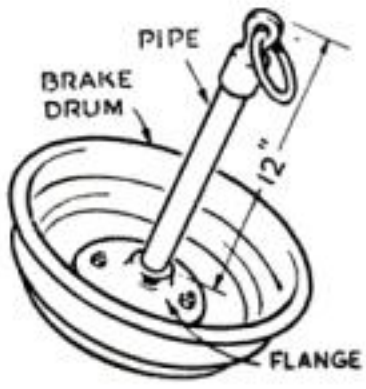



ONE OF the major problems in building a canoe is the shaping of the stem and stern. Although this is usually done by steaming, an easier solution is to use laminated construction. Prepare a wooden jig with the curved edges 2½" apart, or whatever the thickness of the finished piece is to be. Any convenient stock can be used, such as ¾" by 6", which should be nailed together to double thickness. To the bottom of the two jig members screw four ¾" thick guide strips, two to each member, so that they will interlock but slide along the dotted lines indicated in the drawing.

Cut twenty strips of oak, hickory, or other hardwood ⅛" by 2½" by 60", apply waterproof glue liberally to both sides of each strip, and clamp all of them together evenly in the jig. When the glue has set, these will form a very strong piece.—R. H. JENKINS.



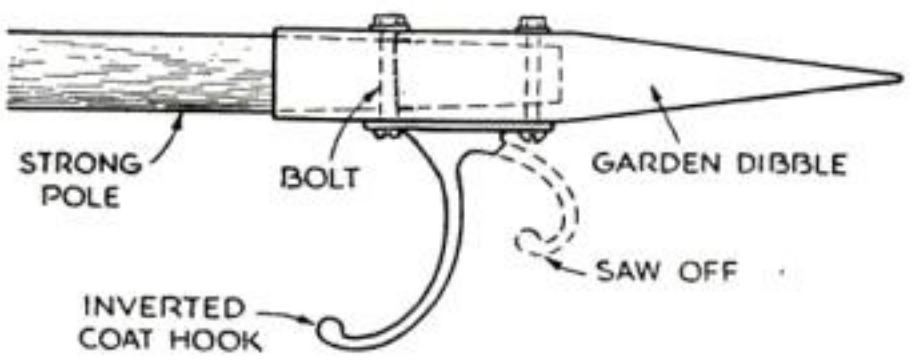

## A Mud Anchor for Small Boats




AS A SUBSTITUTE for the rocks and iron weights which many fishermen use for anchors, an effective mushroom anchor, especially for mud bottoms, can be made from an automobile brake drum picked up in a junk yard, and a 12" length of ¾" pipe. A pipe flange of the same size is bolted to the center of the drum, and the pipe screwed tightly in place so that the open side of the drum faces upwards. Drill a hole through the pipe, or use an eye cap as shown, for the anchor-line ring.—ROBERT HEILMAN.

## Garden Dibble Used as Point of Homemade Boat Hook

A BOATMAN in immediate need of a boat hook made one from materials on hand. The pointed shank of a garden dibble and a coat hook from which the shorter arm had been sawed off were bolted to a strong pole, as shown below.—L. B. R.




# Self-Tacking Vane Gear
## FOR MODEL SAILING YACHTS

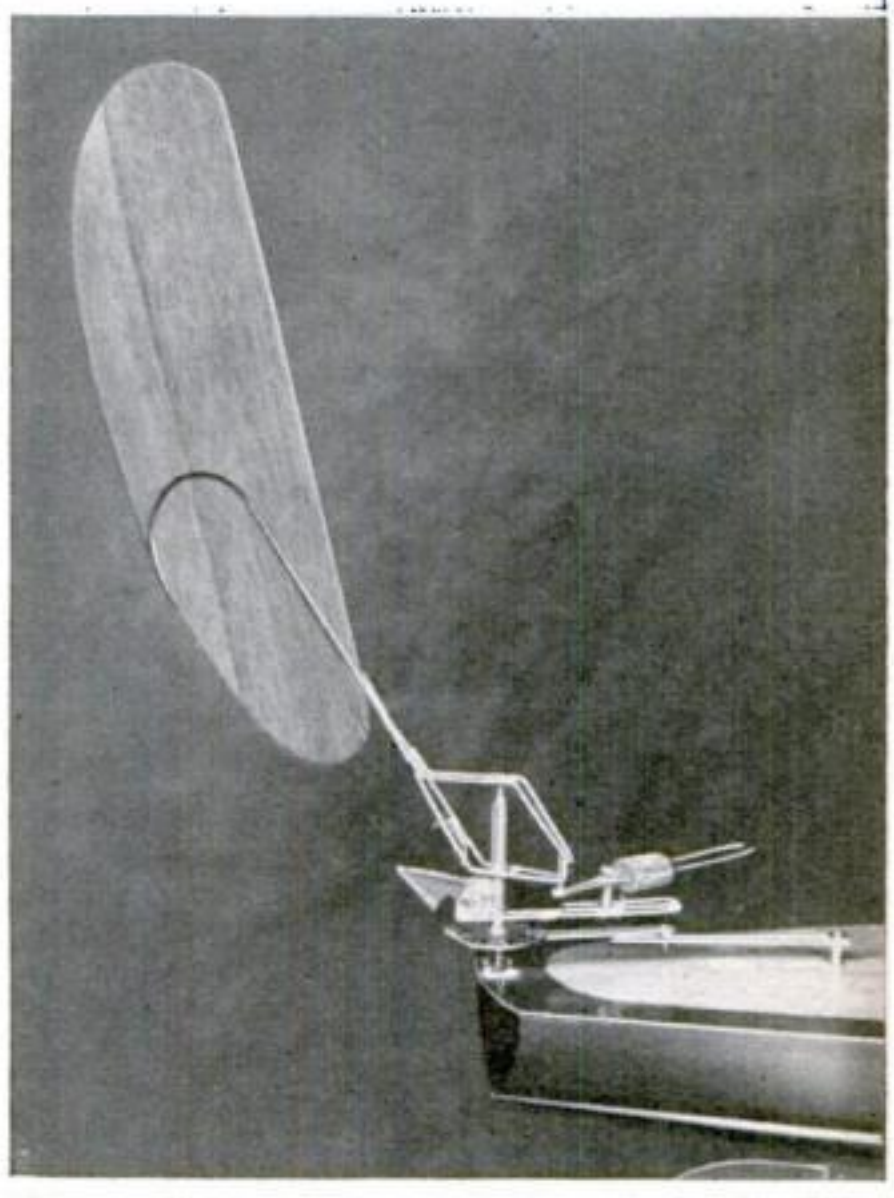
**By JOHN BLACK**

Six times winner of the National A-Class and twice winner of the M-Class Championship; author of *Yachting with Models*

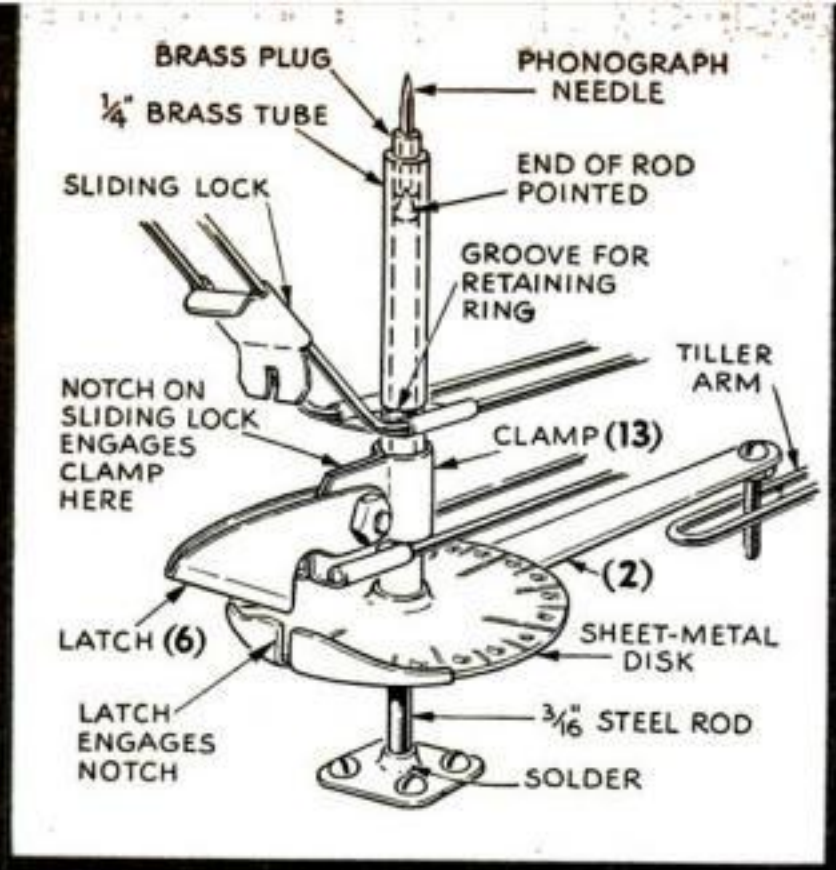
NOTHING in a century of model-yacht racing has added more thrills to the sport than the vane steering gear, which is today to model yachting what the jib-headed mainsail is to full-size yachts and the front steerer is to ice boats.

Its advantages are: 1. The mainsail may be sheeted very close. 2. The jib may be eased off to allow a perfect flow of air between the sails, but will still retain its full lifting power. 3. The model is kept on its course at all times unless the wind changes. 4. The advanced type of gear illustrated allows of tacking with a pole, which gains many seconds in sailing to windward.

This particular type of gear was invented by Dr. T. W. Houk, of the Seattle (Wash.) Model Yacht Club. Its ingenious self-tacking feature, which is new, throws the vane into position when tacking, without manual adjustment. The action is such that the vane always remains in the proper relation



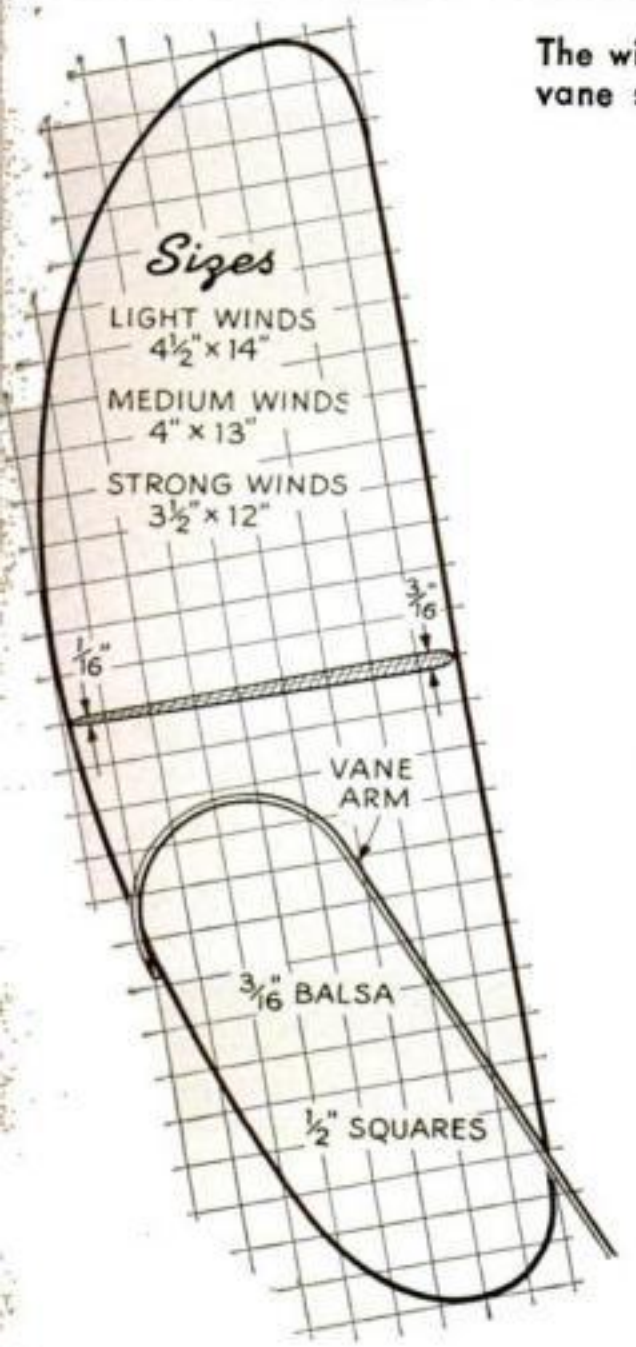
This vane gear automatically swings the helm over as the model is turned about on a new tack



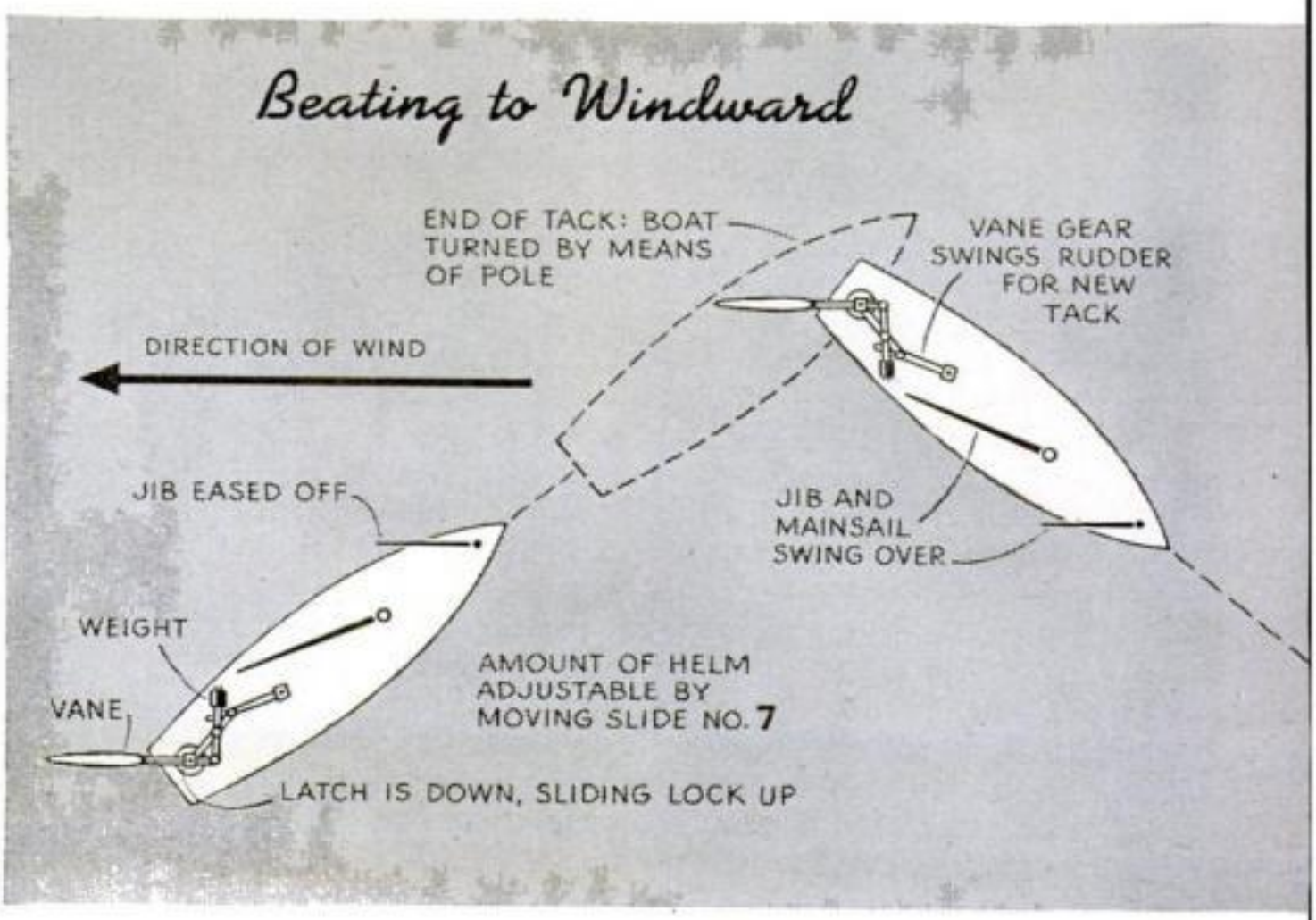




The wire parts of the self-tacking gear can be made of bicycle spokes. Suggested vane sizes for a typical racing yacht appear on the profile drawing at the left




## Beating to Windward



to the amount of helm, which is adjustable.

To be successful, however, such a gear must meet three requirements. First, its construction must be light, yet sturdy enough to prevent the gear from altering its set when under way. Stainless steel is best for the metal parts. The vane itself should be made of balsa wood.

Second, the ratio between the gear and the tiller arm must allow the vane sufficient leverage to keep the rudder in position. A ratio of 60 percent for the tiller arm and 40 percent for the disk arm (2) will serve as a basis for experimentation. These proportions will vary according to the shape of the hull, and the size of the rudder and sails.

The third essential is that the vane itself must have sufficient area to control the rudder. It is better to have the vane too large than too small. Several sizes should be made, the larger ones being used in light winds.

In the gear illustrated, the vane is pivoted upon a needle point spindle (1). The disk arm (2) has a short pin which engages the wire tiller arm. The disk arm and the disk are soldered to a length of ¼" brass tubing (3) mounted upon the inner spindle (4), which is a pointed steel rod fastened securely to the deck. A brass plug is sweated into the top end of the tubing to form the inner bearing, and at the top receives the outer spindle (1), which may be a steel phonograph needle.

The Seattle bar (5) is fixed to the clamp that carries the latch (6). The latter is used to lock the Seattle bar for sailing to windward. The clamp (13) is locked upon the stem (3) by a thumbscrew and nut.

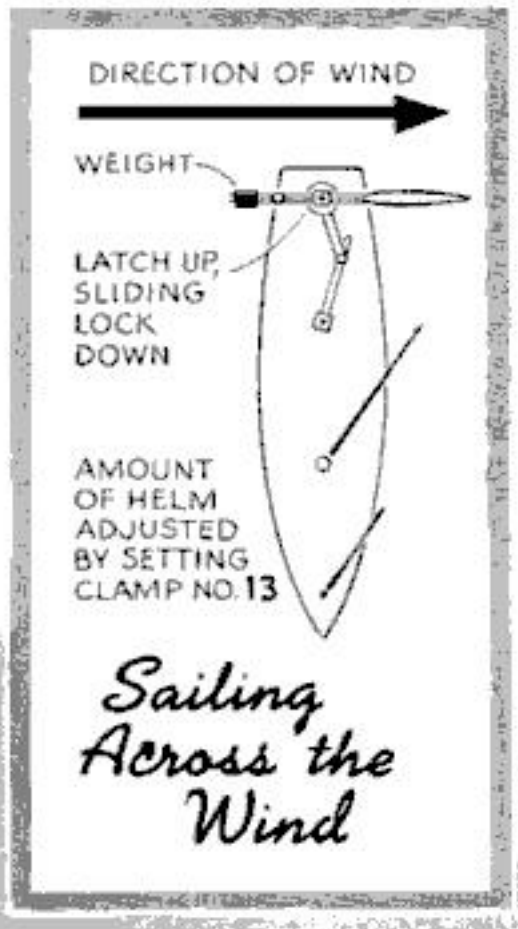
Upon the Seattle bar is mounted the slide (7) on which is pivoted the auxiliary arm (8). This carries at its closed end a pin that engages the inner end of the vane arm (9). On the longer side of the auxiliary arm is fitted a sliding weight of one to two ounces.

A sliding lock (10) is provided on the vane arm. This engages the clamp to lock the vane directly to the Seattle bar for reaching and running. The vane arm is held on the stem (3) by a split wire ring (11).

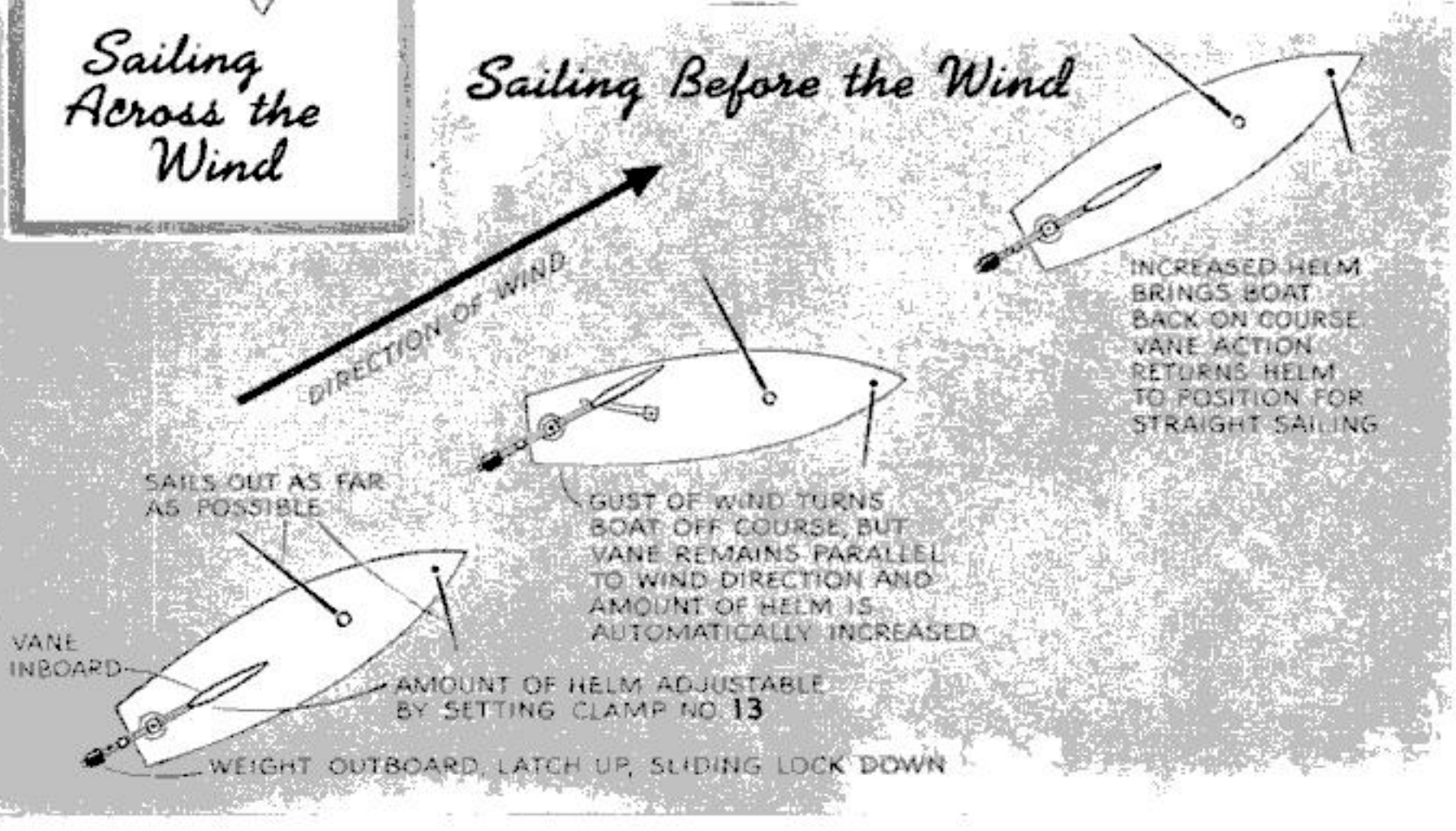
The various settings are indicated in the diagrams, but exact adjustments will be found only after several trials. The disk (12) may be graduated for future reference, if desired.

Take care when tacking to fill the jib, and to make sure that the balancing weight has moved to the same side as the sails.

For guying, both the latch and the sliding lock are disengaged, and the Seattle bar is set as may be necessary by means of the clamp (13).



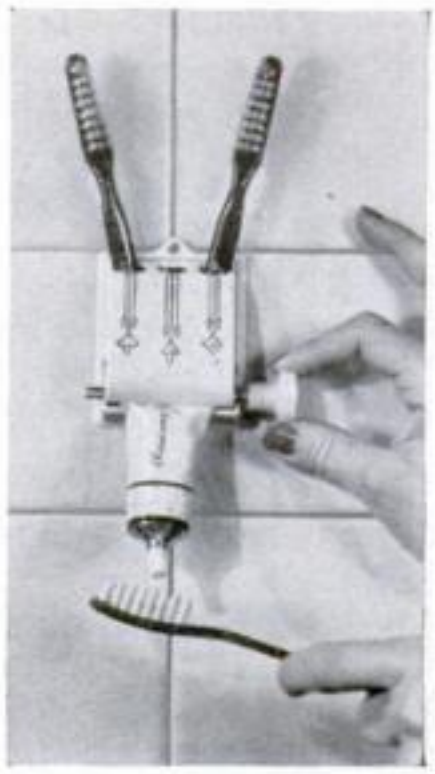

Note that in sailing with the wind the vane is turned inboard. With vane steering, the area of the rudder must be kept small. The width may often be trimmed to advantage, and the depth increased in order to obtain a good grip on the water



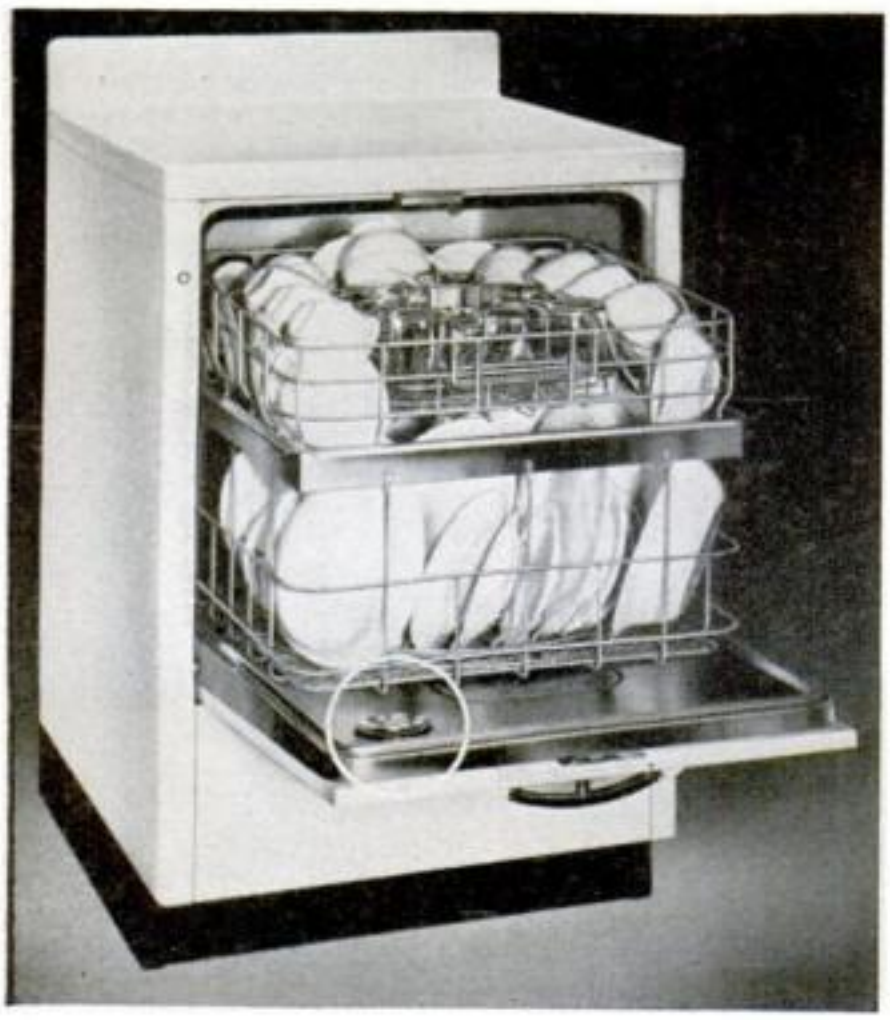
# New Appliances

THIS WASHING MACHINE has a heavy-duty wringer, the drain flume of which automatically shifts when the rolls are reversed. If the roller pressure is released, it can be instantly reset

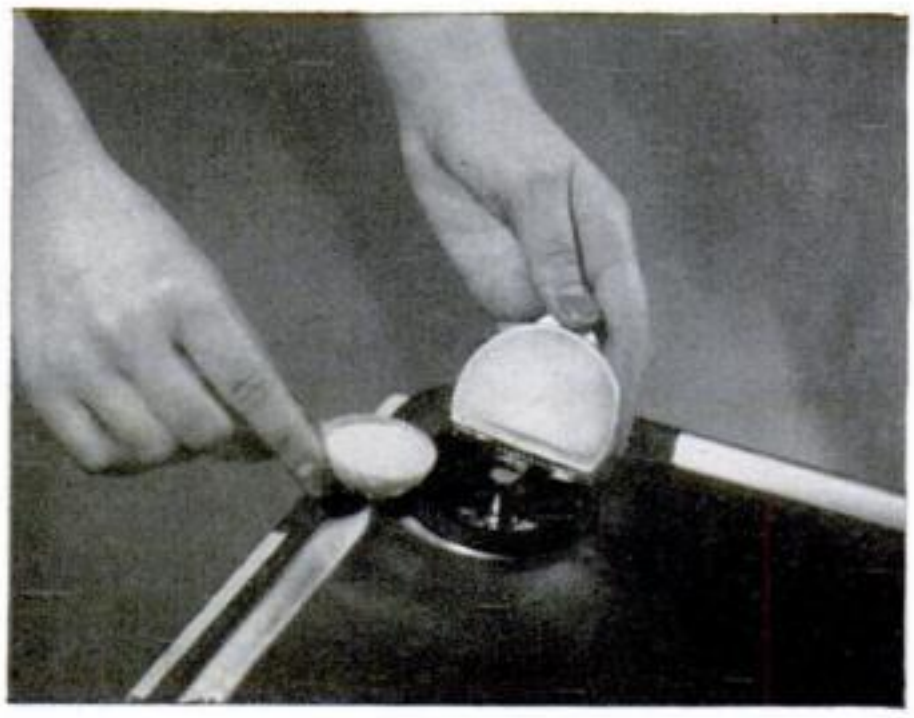
TURNING A KNOB or this plastic dispenser squeezes exactly the desired amount of tooth paste or shaving cream out of the tube. The device also holds three toothbrushes. It is attached to the wall by means of a single screw



WHEN RINGS are removed for any reason, they will not be mislaid if slipped on the pole of the ring safe at the left. Available in several colors, the receptacle resembles a miniature coffee pot



COMPLETELY AUTOMATIC is the electric dishwasher at the left. A timing cam controls all operations, including hot-air drying. A spoonful of a special washing compound, put into a holder as shown below, is automatically released as needed



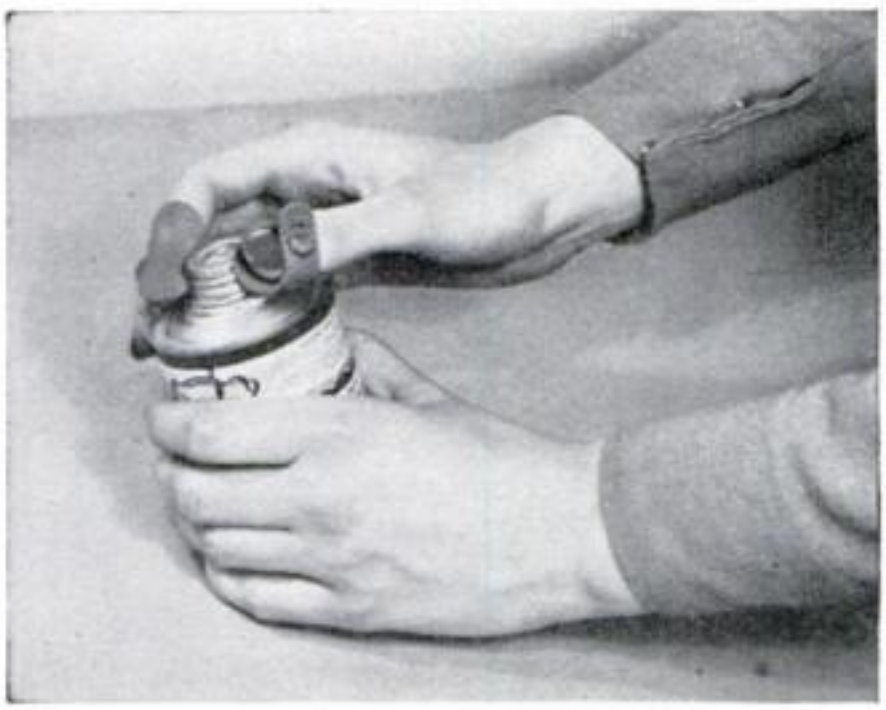
# for the Household

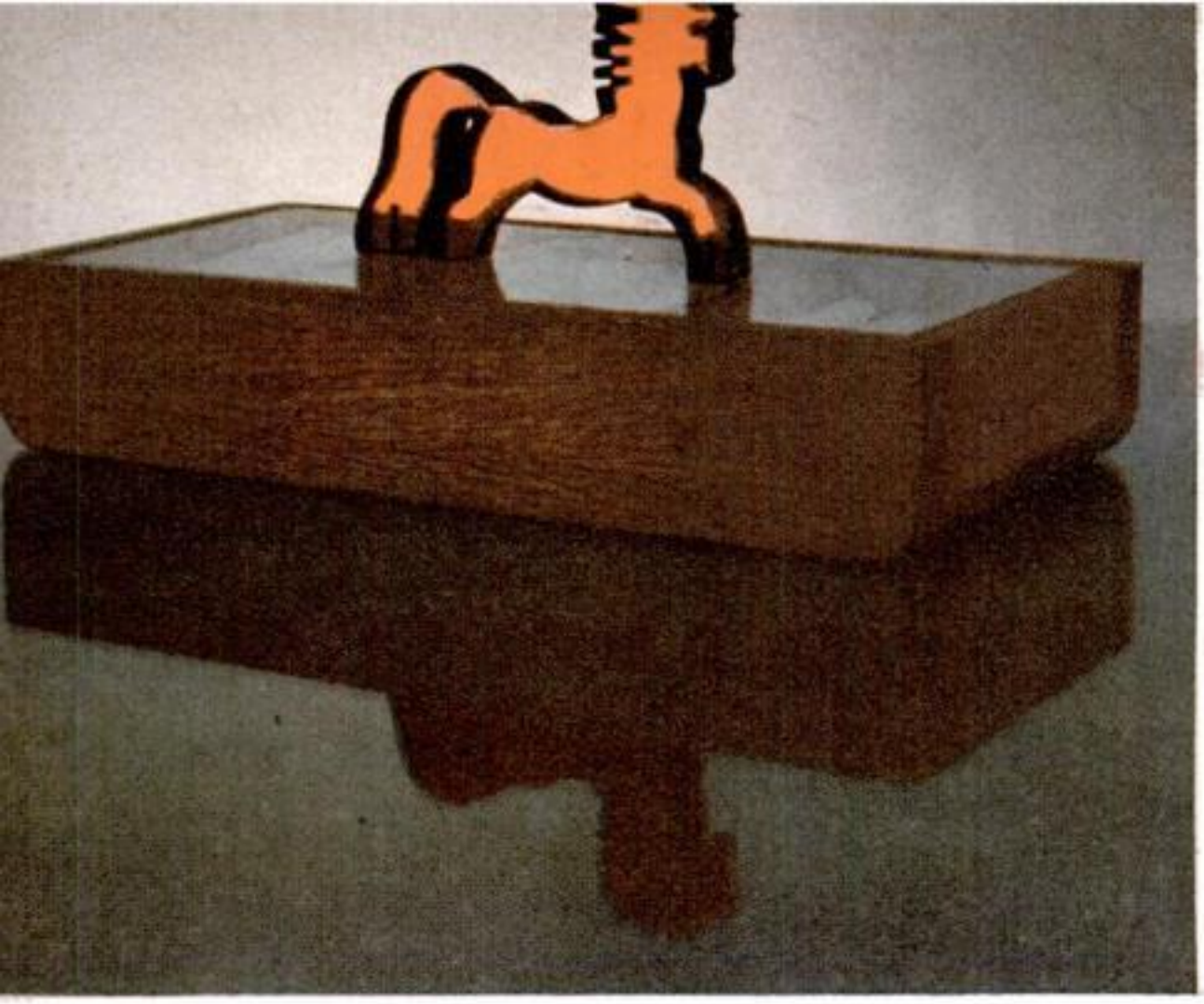
NO BUTTONS, SNAPS, OR ZIPPERS hold this garment bag shut. Two metal inserts, one of which is magnetized, cause the seams of the opening to cling together. The bag will hold eight garments

SELF-WATERING FLOWERPOTS such as shown above will provide plants with moisture for as long as eight days without attention. Water from a covered saucer is fed to the roots by capillary attraction through a wick made of glass fibers

RUBBER FINGER PADS, shown below, make it easier to grip smooth or rounded objects tightly. Adjustable to any finger size, they will not stop circulation, and can be worn with the corrugated surfaces on either the tips or ends of the fingers

A TRANSPARENT and flexible cover that fits any electric or hand-operated mixer permits of using higher speeds without spattering, but leaves contents of the bowl visible. When not in actual use, it serves to keep the blades and shaft clean





# TROJAN-HORSE CIGARETTE BOX

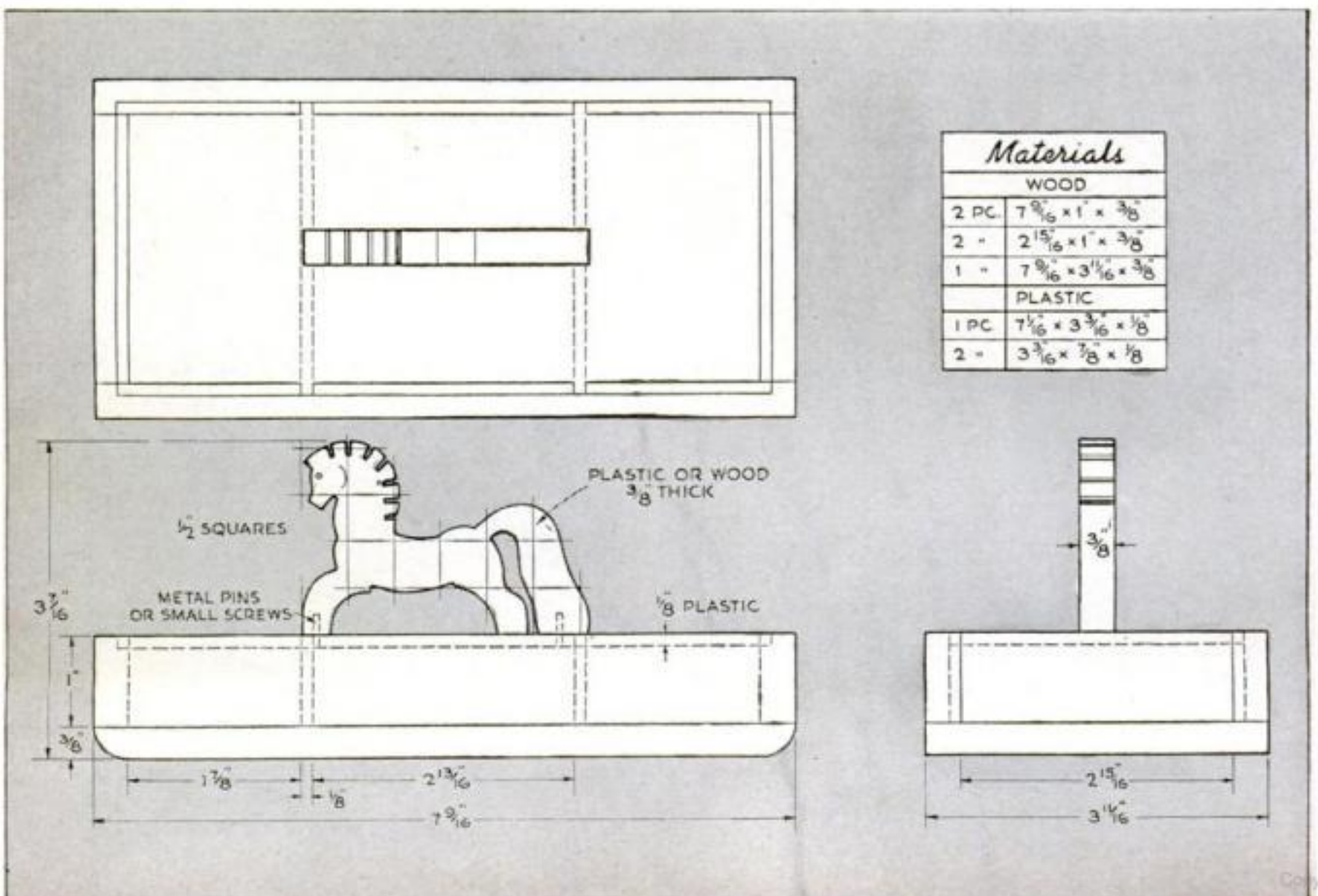
**DESIGNED BY JUAN OLIVER**

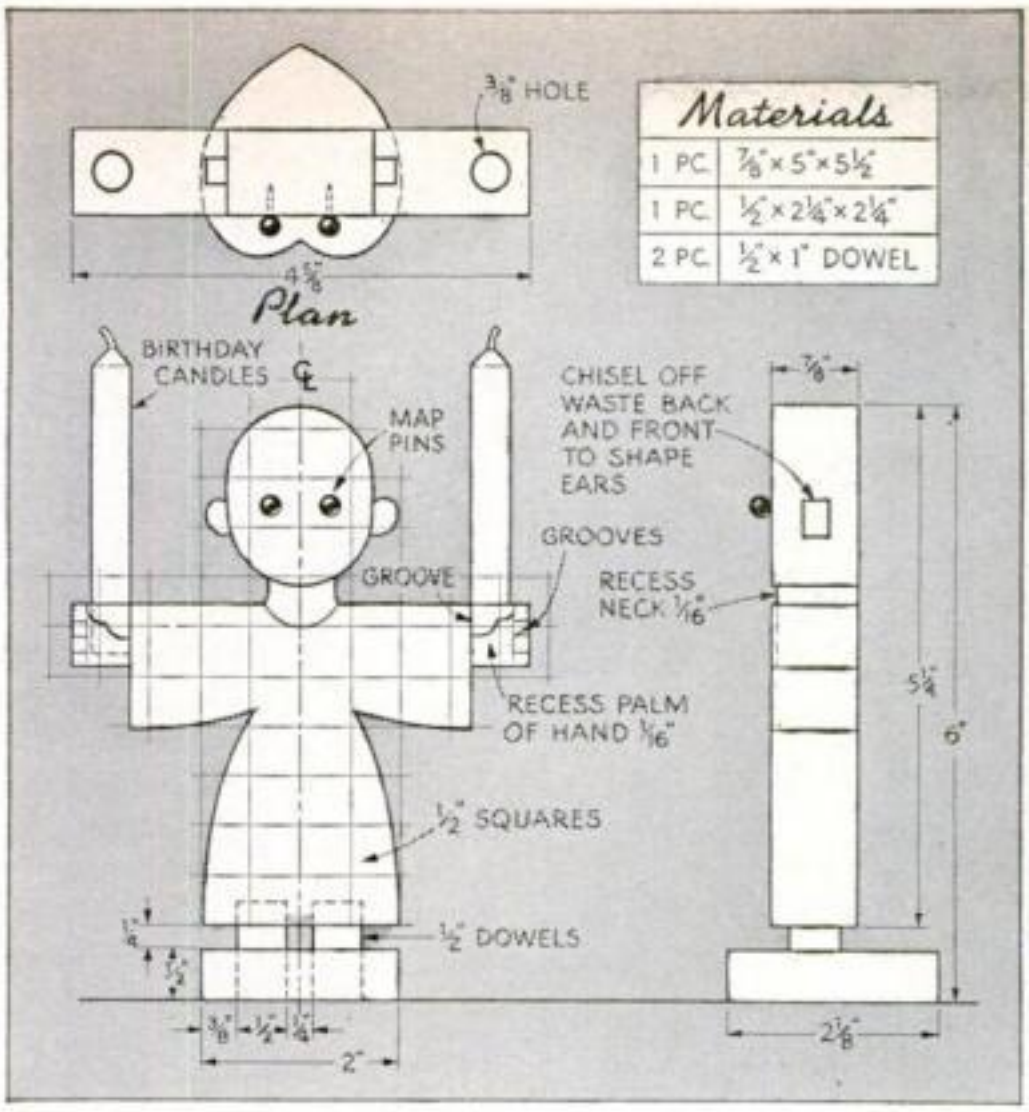
SMARTLY modern treatment sets off this box, which holds twenty cigarettes and matches, or three brands of cigarettes. Its contents are visible through a transparent plastic cover, and the whimsical horse of ruby plastic is both ornament and handle.

The box proper can be made of any nicely grained hardwood. If a circular saw is available, a ⅜" by 1" by 22" strip can be rabbeted ⅛" square along one edge, and the sides and ends cut to size from it. Slot the sides for partitions, and glue up the box on the bottom piece, inserting short pieces of ⅛" square stock at the corners to fill out the rabbet. When the glue has set, round off the bottom at the ends with a block plane or sander. Sand smooth and apply two coats of thinned shellac, sanding lightly after each. Wax and polish.

Cut the cover and partitions to size and fit the latter without gluing. If wood is used, it should match the box. Plastic should be smoothed with fine emery or abrasive paper, used wet, and buffed on coarse and fine wheels.

Trace the horse on paper, using squares, paste the pattern on the material, cut, and smooth with fine files and abrasive paper. If plastic is used, drill holes into the legs and tail for small flathead machine screws, which cut their own threads, and screw to the lid. An alternative method is to drill the plastic undersize for escutcheon pins, heat in water, and push it while hot over the pins, which it will grip firmly when it contracts. Cement may also be used. If of wood, the horse can be glued or bradded to the lid. Average construction time: with a wooden horse, 3½ hours; with a plastic horse, 5 hours.






| Materials | |
|---|---|
| 1 PC. | 7/8" × 5" × 5½" |
| 1 PC. | ½" × 2¼" × 2¼" |
| 2 PC. | ½" × 1" DOWEL |

Simple to construct and amusing as a table ornament is this little candle holder by Juan Oliver, industrial designer

# *Bedtime Willy*
## BRIGHTENS THE PARTY TABLE

THIS little figure will add a droll note to the festive table. A number of such dolls might be used to hold up place cards, or, if pairs are stood back to back, menus, napkins, or paper favors can be put between them. They can be cut out with a hand coping saw, but if a band or jig saw is available, several can be made in one evening.

Draw a full-size pattern on strong paper by tracing the elevation against ½" squares, following the outline on the squares in the accompanying illustration. Also make a heart-shaped pattern for the base. Paste the patterns on wood and cut out. Bore the holes for the legs in the base, then hold the latter against the bottom edge of the body and bore the corresponding holes into it. Drill ⅜" holes in the hands, but only part way through, to receive the candles.

Ears are formed by chiseling away the waste stock, front and back. Undercut the palms of the hands and the front of the neck to a depth of 1/16" Cut shallow grooves at the wrists and between the fingers.

After sanding all parts smooth, glue together the body, legs, and base. Apply two coats of well-thinned shellac, sanding after each coat. Finish with wax, or with one or more coats of white or pastel-color enamel. Insert two colored map pins, short bits of ⅛" dowel, or large-headed escutcheon pins for the little figure's eyes. Two 1" brass washers may be slipped over the candles to simulate candleholders held in its hands. Average time for making each of the ornaments (if sawed by hand), 2½ hours.

## Paper Baking Cups Hold Varnish and Paint for Touch-up Jobs

PAPER cups of the kind used for baking drop cakes are good receptacles for paints or varnishes required for touch-up work and other small jobs. Used once, they can be thrown away.—HAROLD ROLSETH.

## Red-Hot Nail Relights Blowtorch

IF A BLOWTORCH tends to go out because of a poor grade of gasoline or a strong wind, simply insert a small, large-headed nail or a short piece of wire through the holes in the end of the combustion chamber. The wire or nail becomes red-hot, and if the flame goes out the torch is immediately relighted.—ROY HANNING.

Like seals in the circus, this one can throw a ball . . . in this case pennies. An easy way to teach thrift

# Trained-Seal Toy Bank

By KENNETH MURRAY

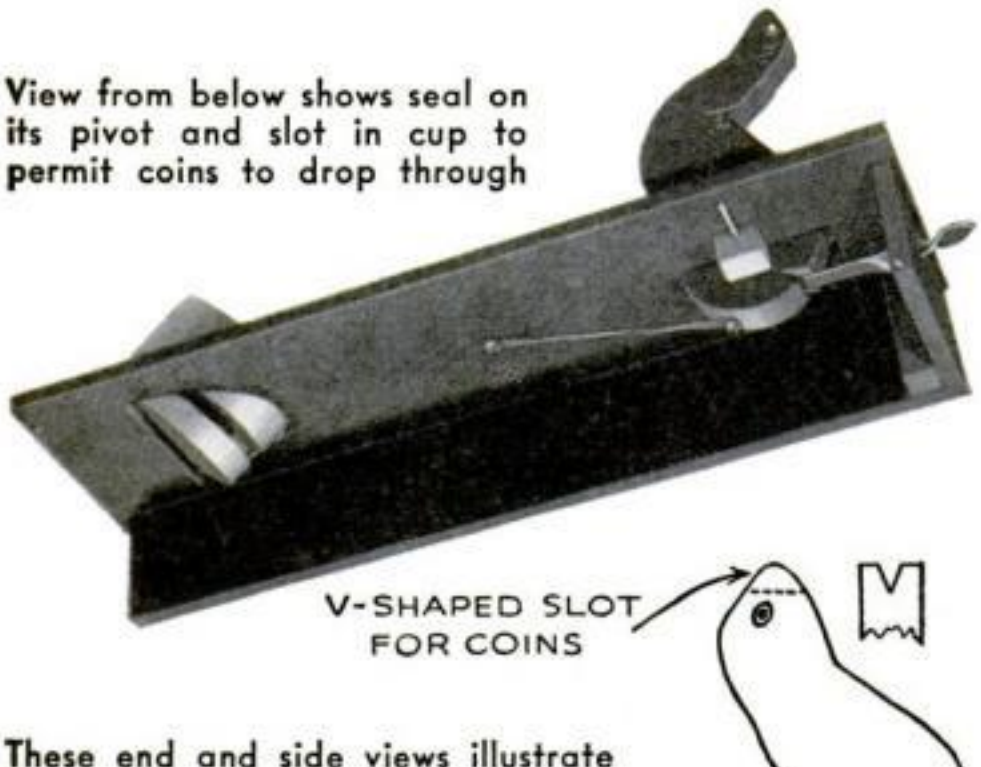
CHILDREN enjoy saving pennies in this novel bank. When the lever is pressed, the seal flips a coin from its nose into a wooden cup, through which the coin falls into the hollow base. Some skill is required to push the lever just hard enough.

Dimensions may be taken directly from the drawings below, which are half size. Most parts can be made of 3/16" hard board (pressed composition wood), plywood, or sheet plastic. Cut a ½" wide slot in the top for the seal, and a semicircular opening for the cup. Make a saw cut halfway down in the center of one of the end pieces. It is also necessary to drill a 1/16" hole in from the edge of this piece for the pin upon which the lever pivots. Glue or nail together the base, using square wooden reënforcing cleats at the corners. The bottom is screwed to these so that it may be removed to take out the coins.

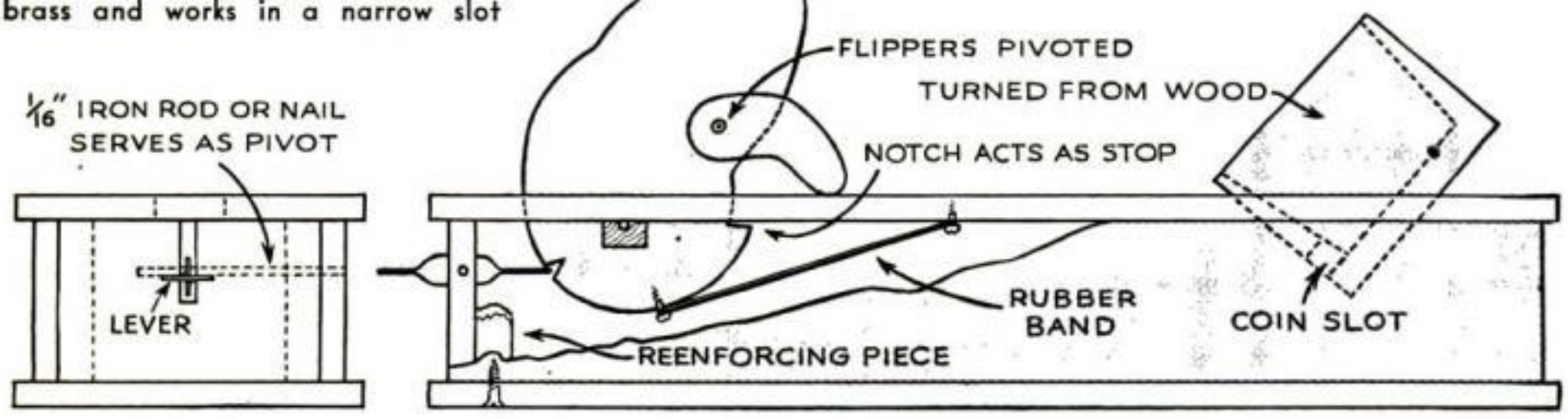
The seal consists of two thicknesses of the material, glued together. The flippers are 3/16" thick, and pivoted on small brass screws. Cut the coin slot in the nose slightly wedge shaped to hold coins of different sizes. Make the lever from a strip of flat brass by bending both ends at a right angle to the middle.

The two bearing blocks are glued to the underside of the top. A rubber band keeps the figure upright and lends the necessary tension to the operating lever. If no lathe is available, the coin box may be made square instead of round.

View from below shows seal on its pivot and slot in cup to permit coins to drop through




These end and side views illustrate how lever swings seal into action. The lever is bent from a strip of flat brass and works in a narrow slot



# Wood and Copper Pipe Rack


*Average Time*
*7½ hours*

MADE of cherry and sheet copper, this pipe rack is one that will delight any pipe collector. It is designed to hold seventeen pipes, and in addition a long-stemmed church warden pipe can be slipped between the copper troughs from either end.

The copper should be 16-gauge, and two pieces measuring 7½" by 14" are required. It will simplify the work a great deal to have a tinsmith make a ½" right-angle bend on one long side and a ¼" right-angle bend on the other long side of each sheet before you take over the work.

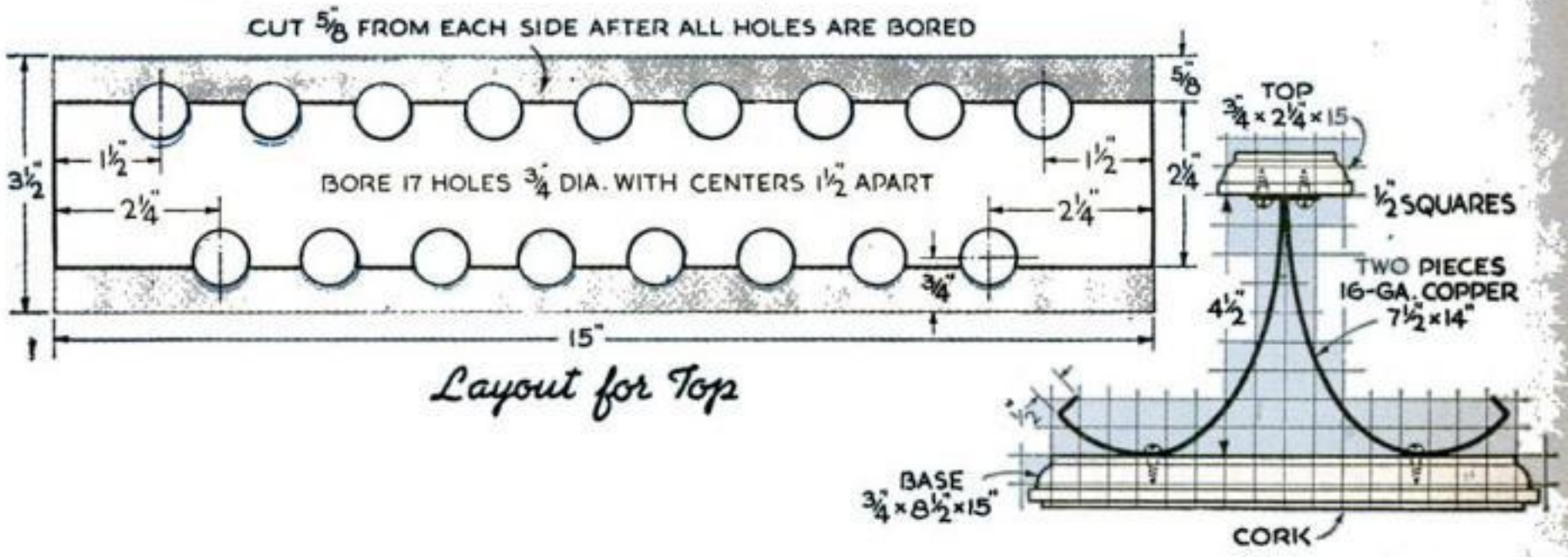
The centers of the two lines of holes in the wooden toppiece were laid out ¾" from each side and staggered, nine in one line and eight in the other. The boring was done with a ¾" bit, and the holes centered 1½" apart. Then a strip ⅝" wide was sawed off each side, leaving the partially open holes into which to fit the pipe stems. The 8½" by 15" base was cut from the same piece of ¾" stock.

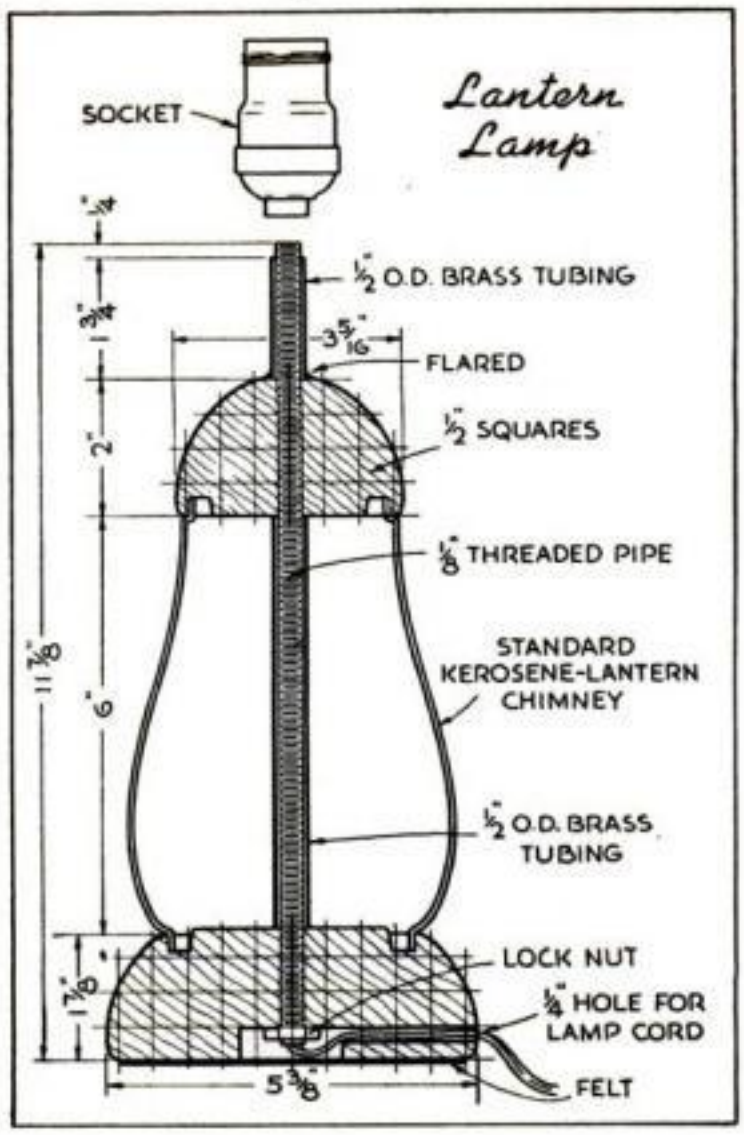
Edges of both bracket and base were trimmed with suitable molding. Sheet cork was glued under the base to prevent scratching the table. Before assembling, all the wood was given several coats of well-thinned white shellac, and each coat was rubbed down smooth with fine steel wool.

The curved copper stands were fastened to the base and bracket with roundhead brass screws as shown in the end view below. The entire rack was then waxed and polished for a high luster.

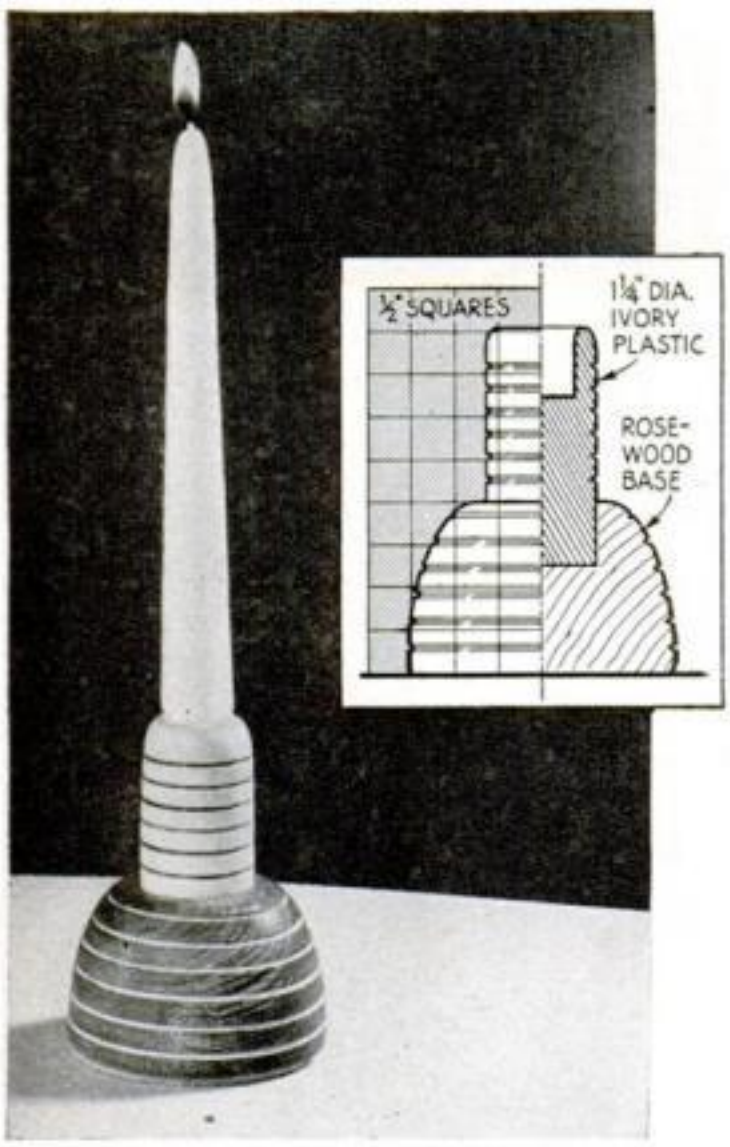
The same principle of construction could be used, if desired, for a shorter rack with a tobacco jar in the center.—MARION E. WESP.

Plan for stem holes in toppiece, and the assembled rack, showing copper attached to base and bracket






Lamp dimensions given may be altered to suit other types of chimneys. Templates are useful in turning parts of the lamp and of the candlestick below



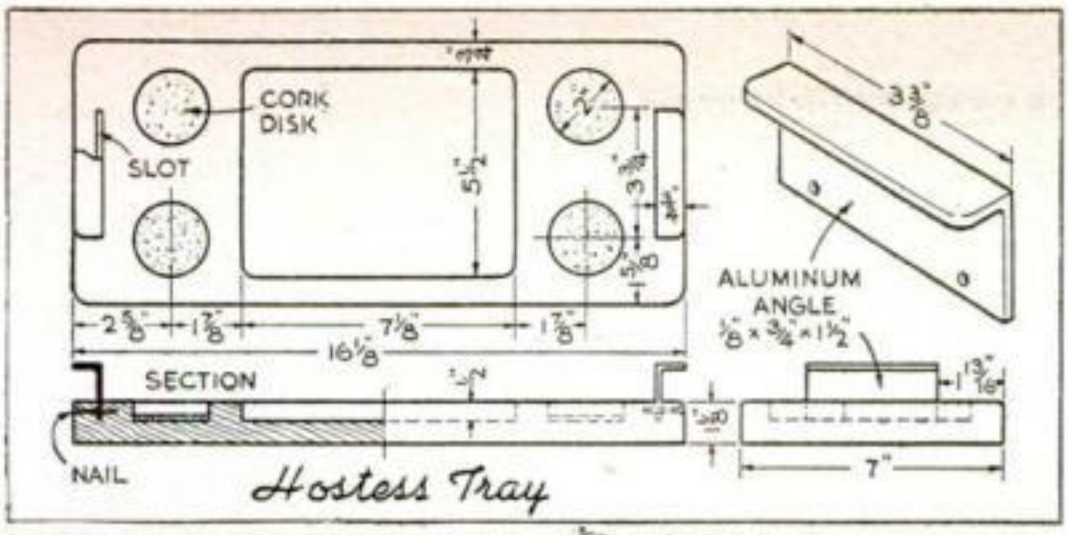

Candlestick

# WORKING

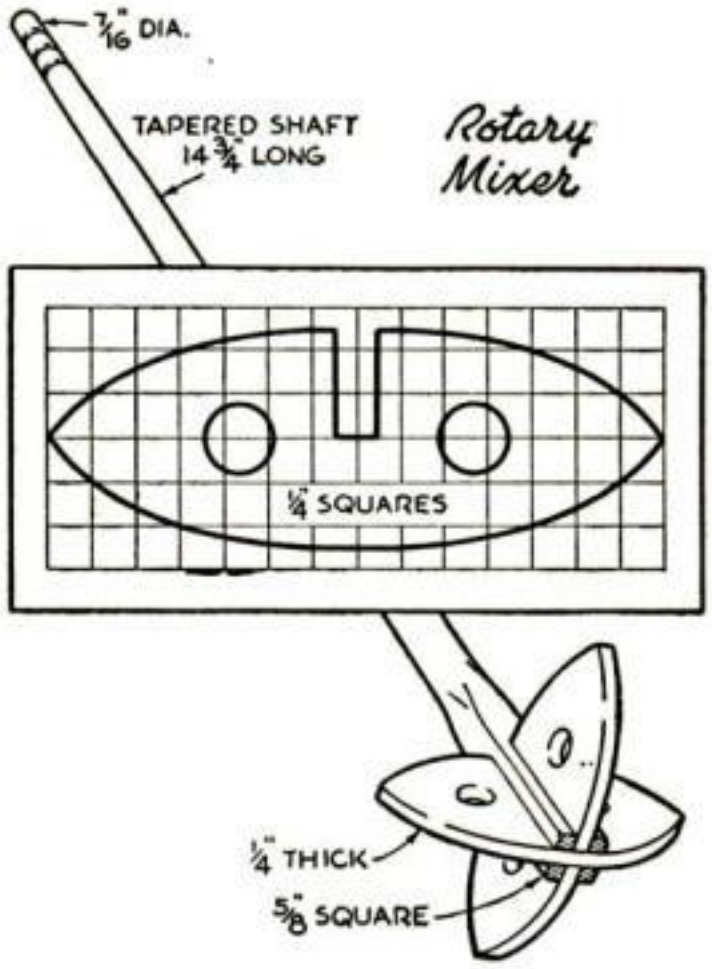
## FOUR CRAFTWORK PROJECTS

ONE or more of these useful articles will find a welcome in almost any home. Their construction involves no difficulty for even the beginner, and if the materials are on hand, any of the projects shown can be made in an evening.

**LANTERN LAMP.** A colored kerosene-lantern chimney forms the body. The base and crown are turned on the lathe to the contours shown. Cardboard templates made from the drawings will prove helpful. The grooves for the top and bottom shoulders of the chimney should be somewhat oversize. After making the one in the crown, remount this piece to turn it to shape. A ⅜" center hole is bored in both of these parts, and that in the base is counterbored from beneath for a lock nut fitting on the ⅛" continuous-thread pipe that clamps the parts together. A ¼" hole is drilled in from the edge of the base for the lamp cord. The wooden parts are given two coats of clear lacquer or shellac, then waxed and polished. A piece of brass tubing between the crown and lamp socket conceals the pipe threads, and the bottom of the socket is screwed on tightly to lock the assembly. To make a somewhat smaller lamp, use one of the shorter lantern chimneys instead of the type shown. Approximate time, 4½ hours.




Hostess Tray




Rotary Mixer

# TIME: ONE EVENING

## DESIGNED FOR POPULAR SCIENCE BY ERNEST R. DEWALT

**CANDLESTICK.** Rosewood and ivory plastic were used for the candlestick illustrated, but other combinations are possible. Make a template for turning the base, which is accented with six grooves 1/16" deep. Turn out a hole ¾" deep to a close fit for stock-size plastic rod (about 1¼" diameter). Insert the plastic while the base is still in the lathe. Wood-turning tools may be used for turning the candle socket and the grooves, but must be sharp and should be held only at a scraping angle. Sand smooth in the lathe. Apply flat white paint to the wood, rubbing it in well. Rub burnt sienna (oil paint) into the grooves in the plastic for an added color accent. The plastic may be left dull, or buffed and polished. Wax the base. Time, 3 hours.

**HOSTESS TRAY.** This can be made of oak, as was the tray shown, or of chestnut, maple, or walnut. Bore out the glass recesses with an expansive bit to a depth of ½". The center recess is cut with a ½" router bit to the same depth. Clamp a piece of wood to the drill-press table as a guide fence when working along the straight edges. The handles were cut from an aluminum angle, but could be bent from any available scrap metal. Rout two ⅛" channels ½" deep in the body, insert the handles, and drill holes from the edge of the base for escutcheon pins or trunk nails. Round off the tray corners, smooth all over, and finish the body as desired. A handsome modern finish is obtained by rubbing flat gray or white paint into the pores, allowing it to dry, then waxing well. Cork disks may be glued into the glass wells to cover the pilot holes left by the bit. Time, 4½ hours.

**ROTARY MIXER.** Long enough for use in deep pitchers, this mixer or "swizzle stick" is twirled between the palms. Spanish cedar or oak may be used. The shaft is ripped ¾" square, then rounded to within 1½" of the bottom on the lathe or with a block plane. Dress the unrounded portion to ⅝" square, and slot it for the paddles. The grooves at the end can be made by revolving it against a circular saw set to cut 1/16" deep. The paddles should be either pegged with wooden pins or glued in with waterproof resin (plastic) glue. No finish is applied. Time, 3 hours.

# MAKE-UP

SIMPLICITY, beauty, and utility are combined in this modern make-up box.

Three disks 8⅜" in diameter are cut from ¾" walnut or other hardwood. Two of these disks are glued together for the bottom part of the box; then these are glued to a piece of waste stock, mounted on the faceplate of the lathe, and turned to a diameter of 8¼". Next a rounding groove ⅛" deep is turned in the edge as shown in the cross-section drawing.

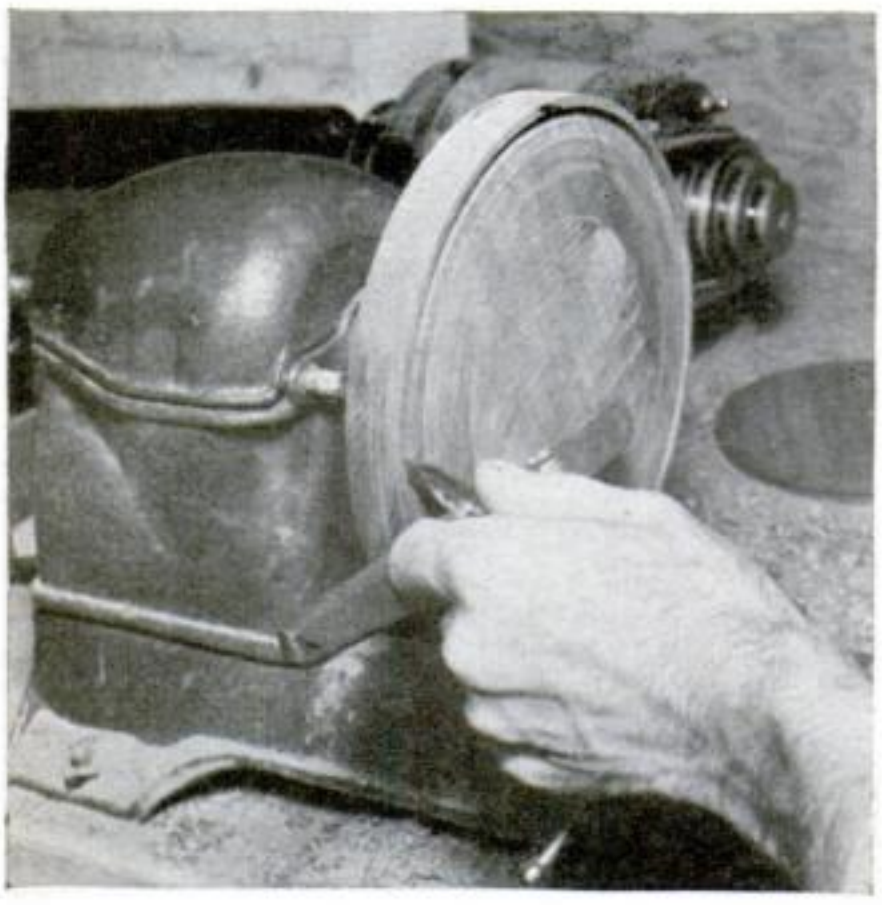
The work is now removed from the faceplate and remounted 3/16" offcenter. This method of offset mounting gives a wider space at the back for the hinges and adds to the

Welcome on any woman's dressing table, this modern make-up box of decoratively grained hardwood combines simplicity, beauty, and utility. Fairly simple also is the work required of the craftsman

Clocked Project

*Average Time*
*10 hours*

Below, turning groove in underside of the lid for insertion of a reënforcing ring. And next . . .



Lid is mounted offcenter and inside is turned out. The attractive offset provides room for the hinges

# BOX TURNED ON LATHE

general attractiveness of the box. The inside is turned out to a diameter of 6¾" and 1¼" deep; it is then sanded thoroughly, shellacked, and polished while still in the lathe. The box is finally remounted on center to finish the outside surface.

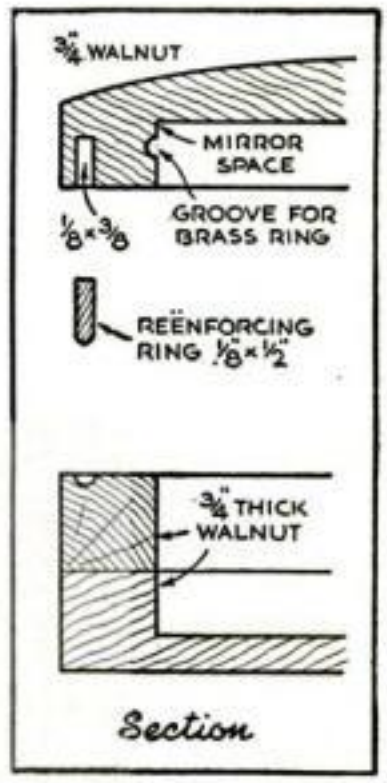
For the lid, the third disk is glued to a piece of waste stock and turned to a diameter of 8¼". Then a groove ⅜" deep and ⅛" wide is turned in the underside of the lid to take a reënforcing ring. This ring is next cut ½" deep and ⅛" wide and is inserted with its grain running opposite to the grain of the lid. The exposed edge of the ring is rounded to fit into the groove in the upper edge of the bottom section of the box.

After being removed from the lathe, the lid is remounted 3/16" offcenter, to match the offset of the bottom of the box, and turned out to a diameter of 6¾" and a depth of ½".

A groove, as indicated in the drawing, is cut to take a brass ring, which holds the mirror in place. The inside edge of the top is now shellacked and finished. Next a piece of waste stock is glued to the inside of the lid so it may be mounted on the faceplate. The first piece of waste stock is turned off and the top slightly rounded. Shellac is applied to the lid, which is finished in the lathe. Then the remaining waste stock is turned off.

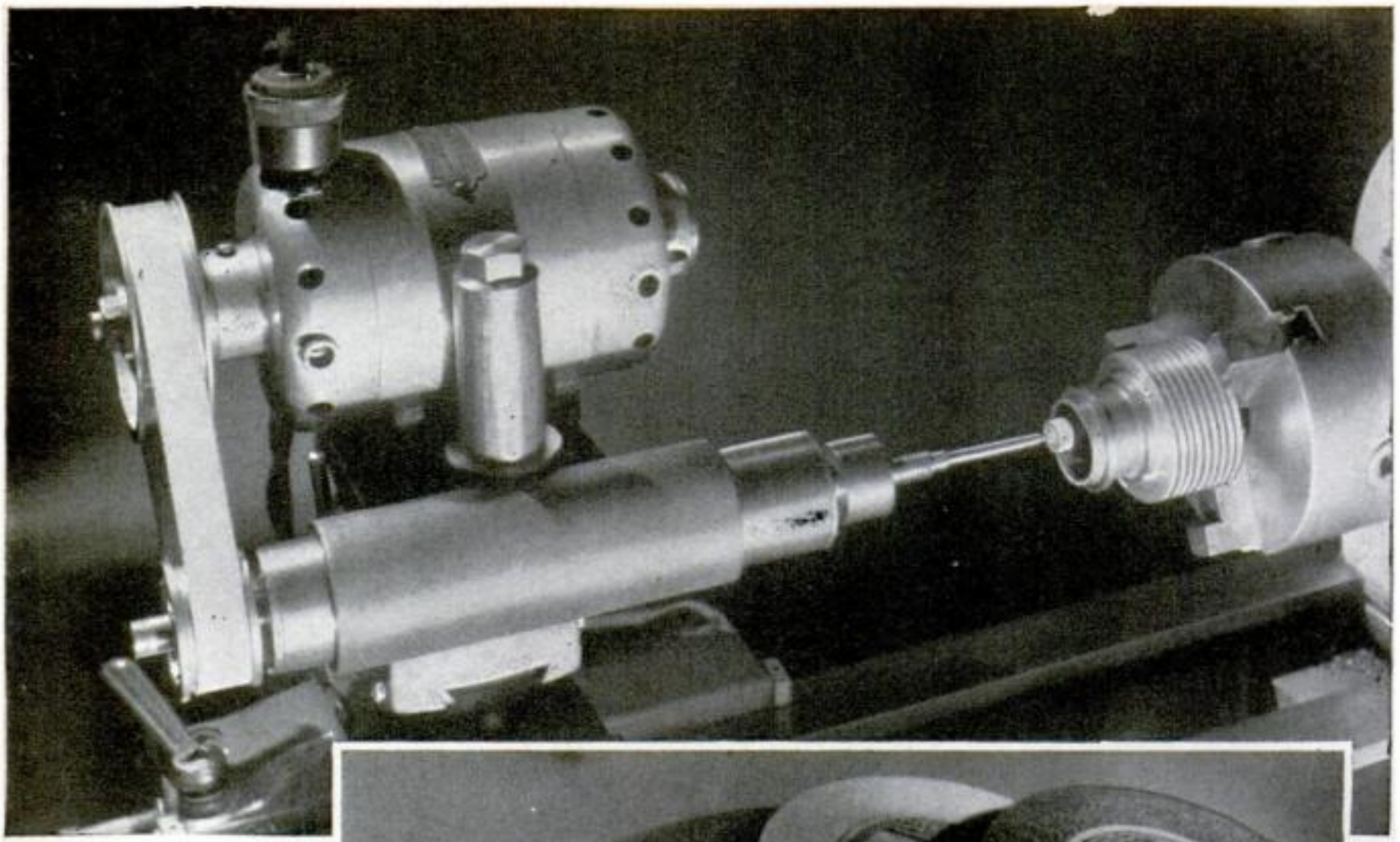
Shallow grooves are cut in the sides of the bottom part to take a walnut dividing strip, which is ⅛" by 1" by 7". This strip has to be slightly bowed in order to insert it. Fasten the mirror in place, and attach two small hinges and a stop ribbon. Felt or blotting paper should be glued to the bottom of the make-up box to protect polished surfaces.

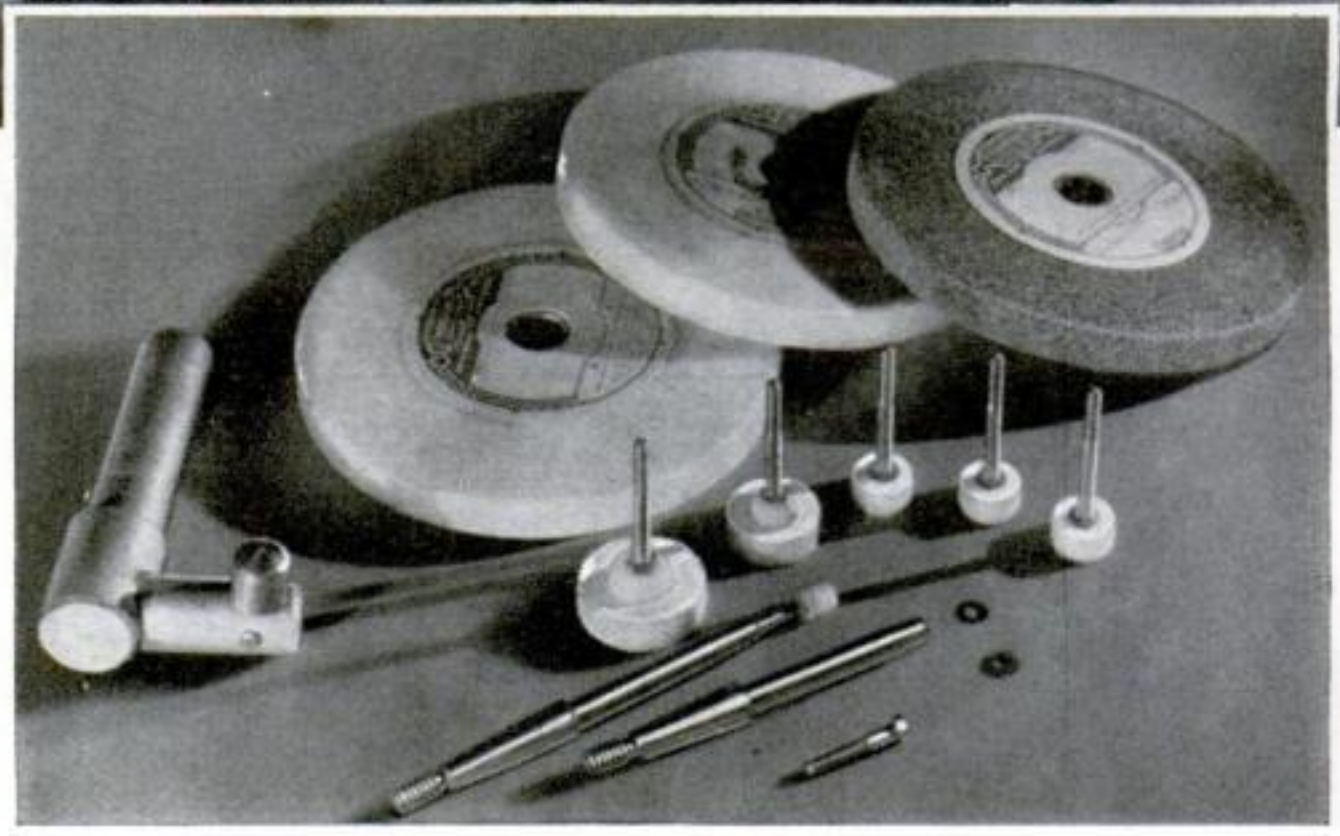
Section shows position of grooves in lid for mirror and reënforcing rings, and matching bottom groove. Note forward bowing of partition in sketch below




Dividing strip put in position in bottom of box. It must be slightly bowed in order to insert it

One of the finishing touches. A mirror goes into the lid, and a brass ring is fitted to hold it in place





① The attachment set up for internal grinding, and typical wheels for use with it. The diamond dressing tool (at left) is a necessity for precision work

By C. W. WOODSON

# Precision Tool-Post Grinder

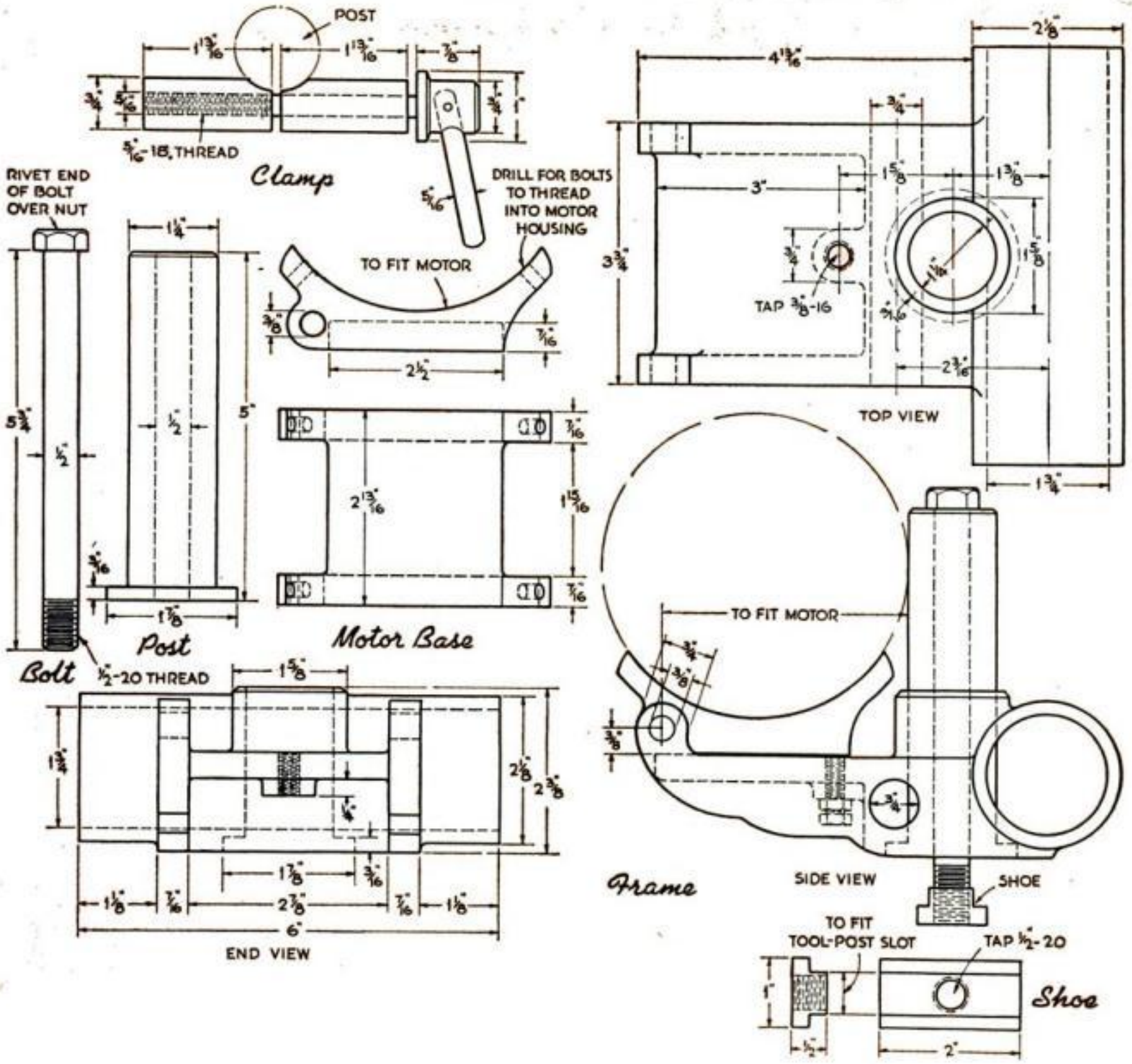
## FOR THE SMALL MACHINE SHOP

THIS attachment, mounted on the cross slide of the lathe, brings precision grinding within the scope of the small machine shop. It is designed to use both external and internal wheels with accuracy (Fig. 1), and will handle a wide variety of work on materials ranging from soft iron to hardened tool steels and glass-hard nonmetals.

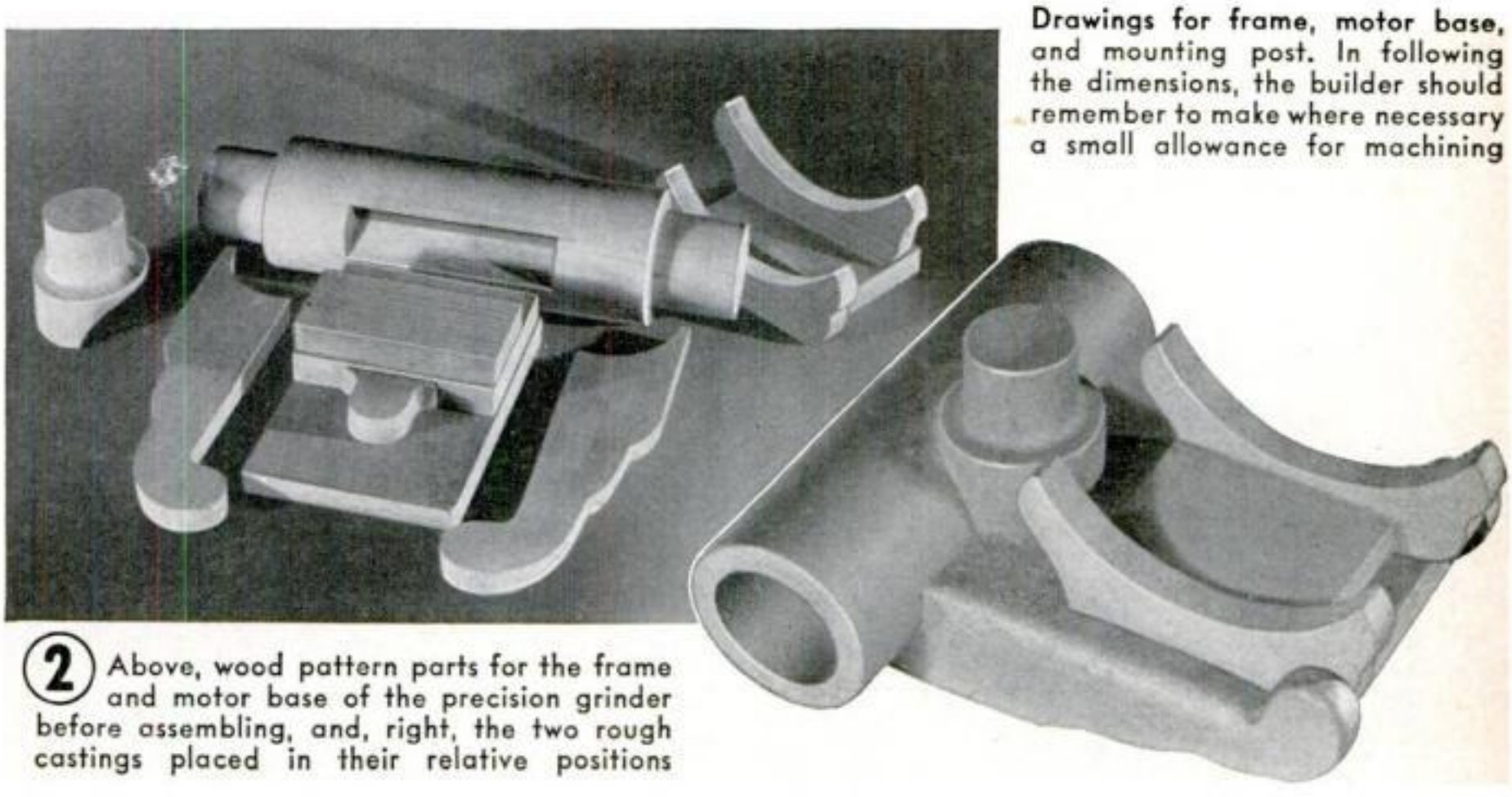
The most important factor in building a grinder of this type is wheel speed. A high-speed motor is required to obtain the 5,000 surface feet per minute that grinding-wheel manufacturers recommend. To turn up this speed with large wheels is easy, but with small internal wheels it becomes a problem.

A wheel 2" in diameter, for example, must revolve at nearly 10,000 r.p.m. to reach a surface speed of 5,000 feet per minute, whereas a ½" wheel will have to turn at 38,000 r.p.m. These high spindle speeds can best be obtained by using a high-speed series-wound motor of the type shown in the photographs. The motor illustrated is rated at ¼ h.p., idles at 15,000 r.p.m., and runs at 10,000 r.p.m. under grinding load. Various pulley combinations give spindle speeds from 4,000 to 40,000 r.p.m., making it possible to drive ¼" to 4" grinding wheels at approximately correct surface speed.

The grinding quill, to withstand these

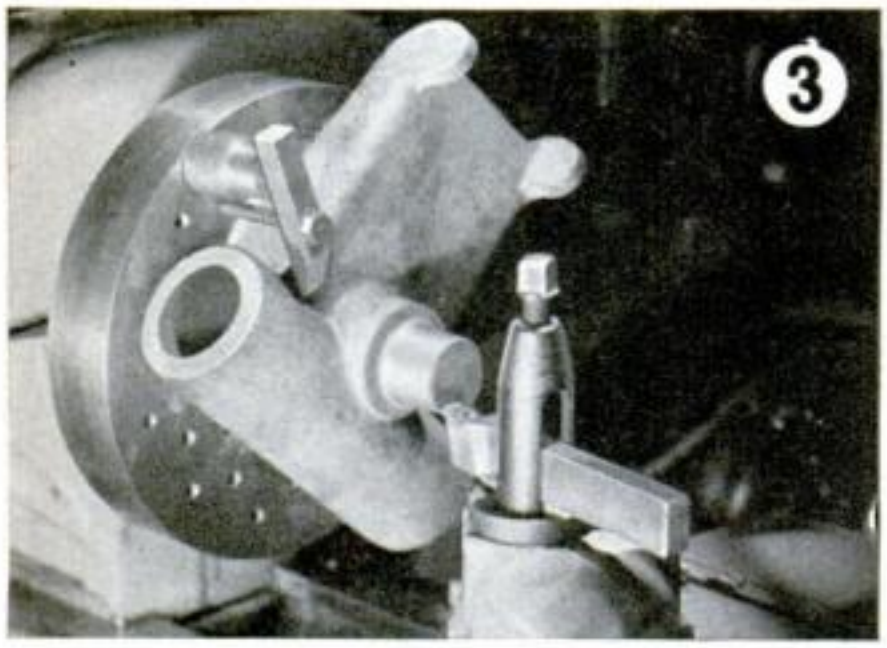


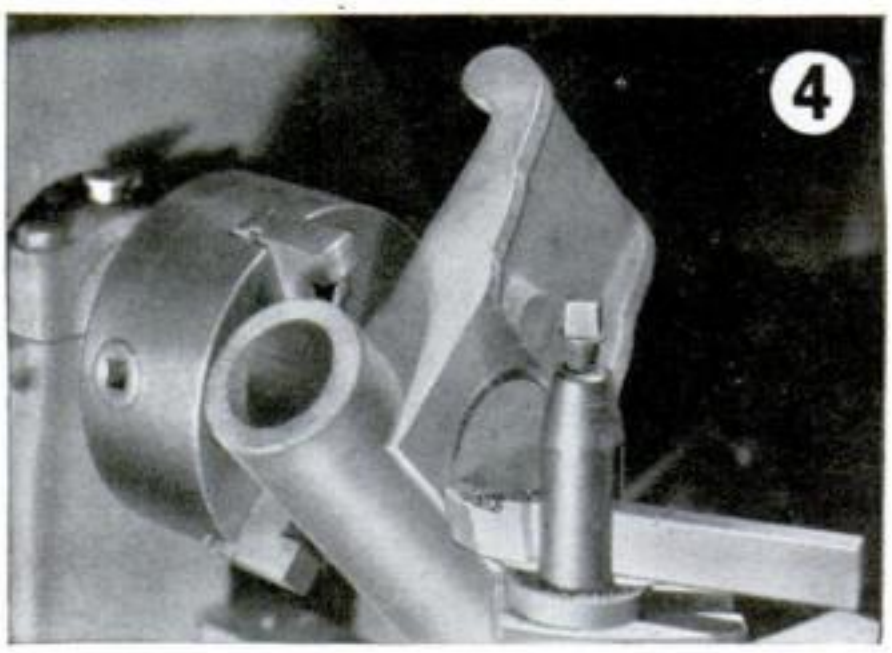

Drawings for frame, motor base, and mounting post. In following the dimensions, the builder should remember to make where necessary a small allowance for machining

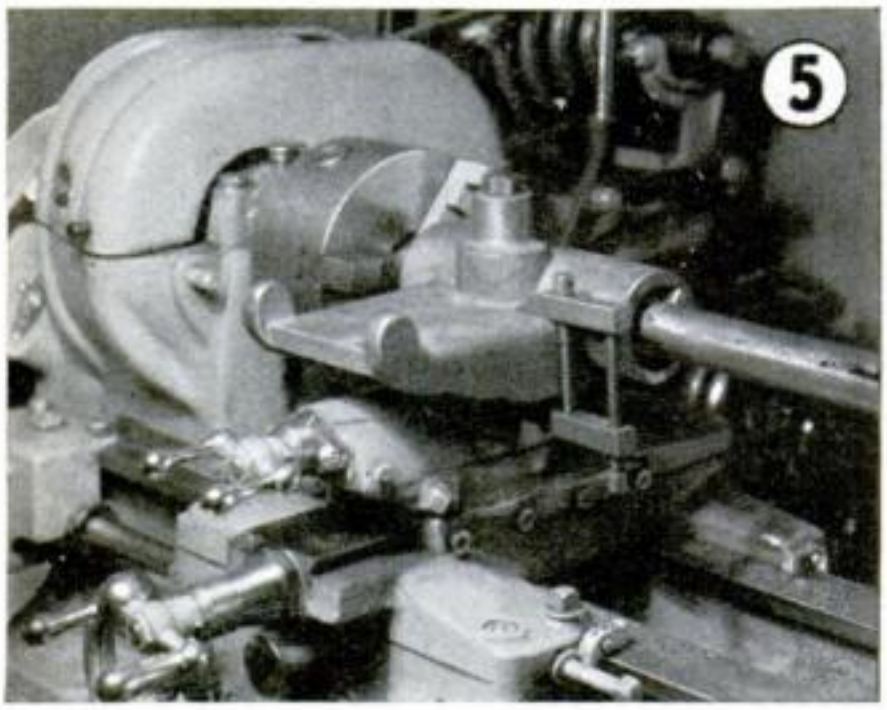


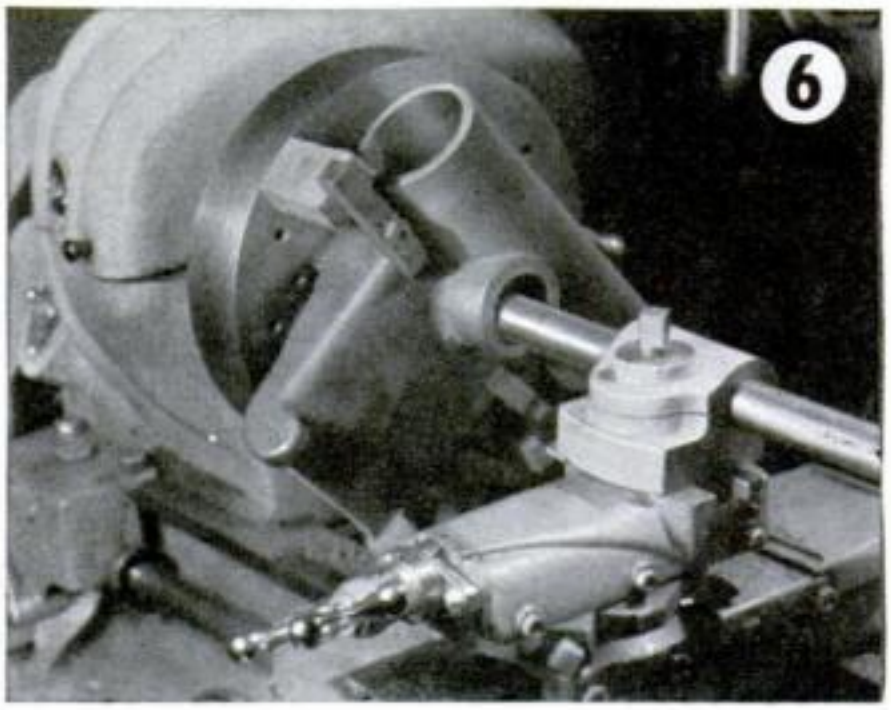
(2) Above, wood pattern parts for the frame and motor base of the precision grinder before assembling, and, right, the two rough castings placed in their relative positions

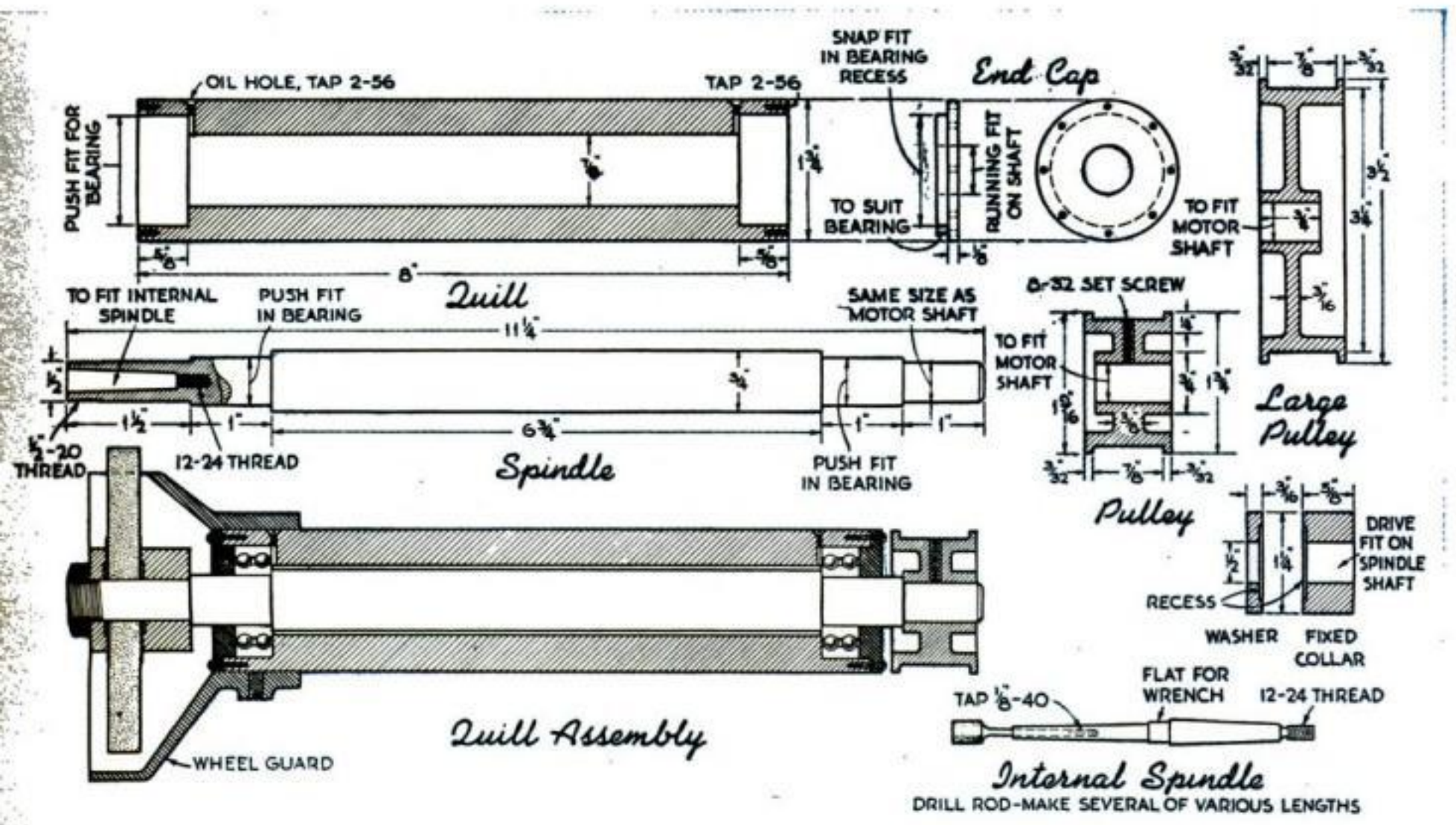
speeds, must be a sturdy, precision-built unit. The quill housing is best turned from a solid bar of cold-rolled steel, drilled through from end to end and recessed at both ends to receive the ball bearings. The spindle should be of drill rod. The main frame and the motor base are iron castings, which require wood patterns of the dimensions in the drawings, plus a small allowance for machining. Some parts of the patterns were turned on the lathe, others cut on the jig saw. Core prints should be added to the



main-frame pattern so that the large hole for the quill can be cored in at the foundry when the castings are made. The parts were glued with water-resistant cold-water plastic adhesive. The patterns were well sanded and all sharp angles rounded out with beeswax fillets run in with a hot steel rod, then given two coats of shellac and sent to the foundry. The parts of the patterns and rough castings are shown in Fig. 2.

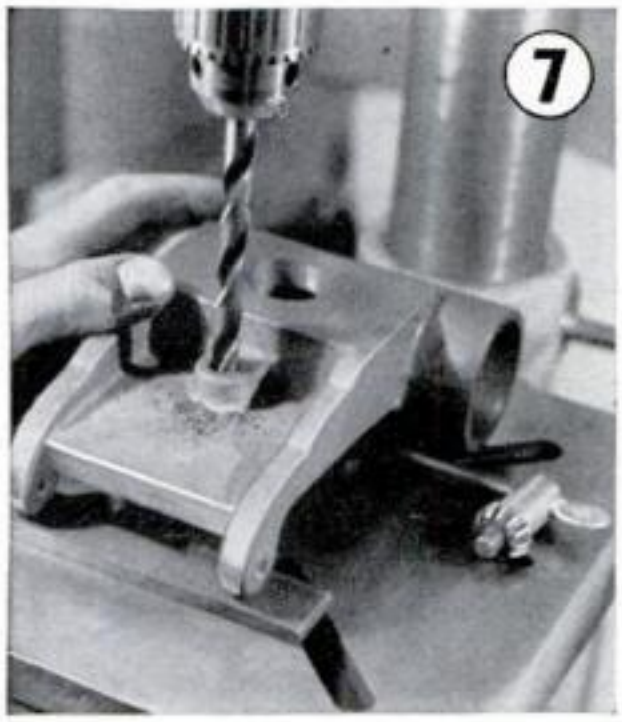
That for the main frame was mounted on the faceplate, as in Fig. 3, and the chucking lug, which was cast on for machining the bottom, was turned straight and true. The casting was then held in the chuck by this projecting lug, Fig. 4, and a facing cut was taken across the base. At this chucking a hole was drilled for bolting the frame to the compound rest, in the position in Fig. 5. The hole for the quill was bored with a home-made boring bar in which an adjustable cutter bit was held with a hardened set screw. Care should be used to locate this hole precisely in the center of the casting. A number of light cuts were made at slow speed and with fine feed. A plug gauge was employed in bringing the hole to the exact size of the outer diameter of the quill, which must fit snugly.

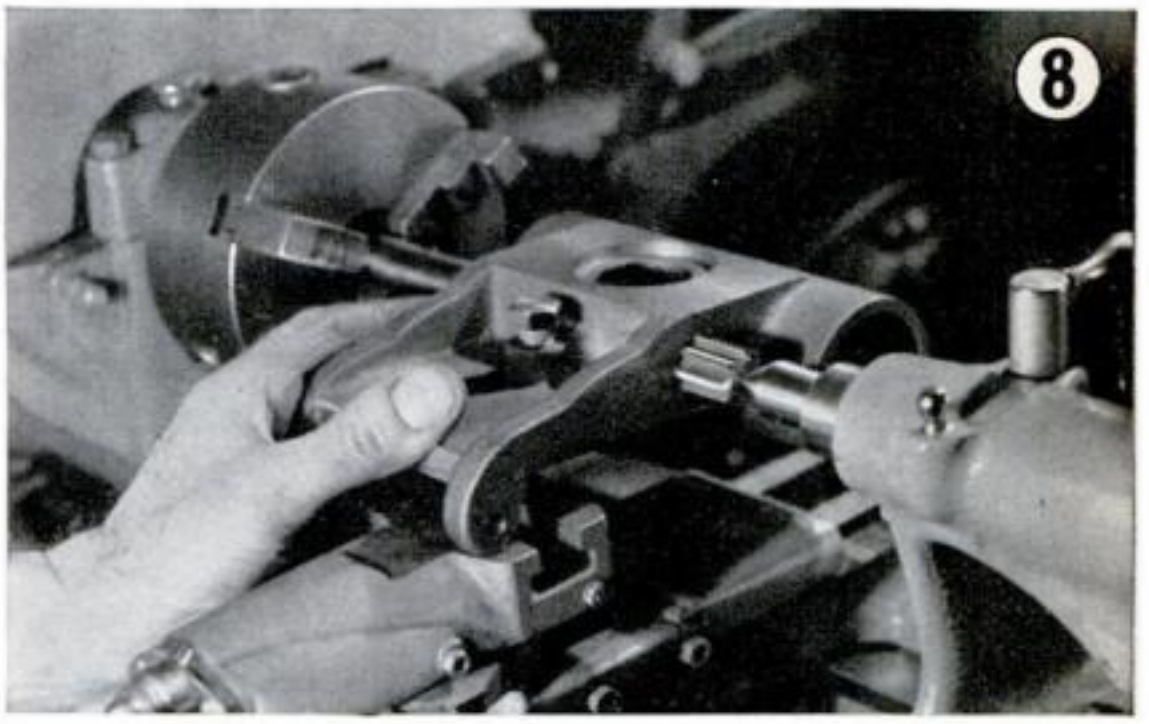
The hole for the mounting post was next bored as in Fig. 6. This breaks into the large hole for the quill, and it is therefore necessary to file a notch in the quill housing to clear the mounting post. By means of the notch the quill is held firmly and the pulleys are kept aligned. Figure 7 illustrates the drilling of the hole for the belt-adjusting screw. In Fig. 8 the hole for the post clamp is being reamed. However, it might be preferable to drill and ream this hole before boring the post hole, as they also overlap slightly.

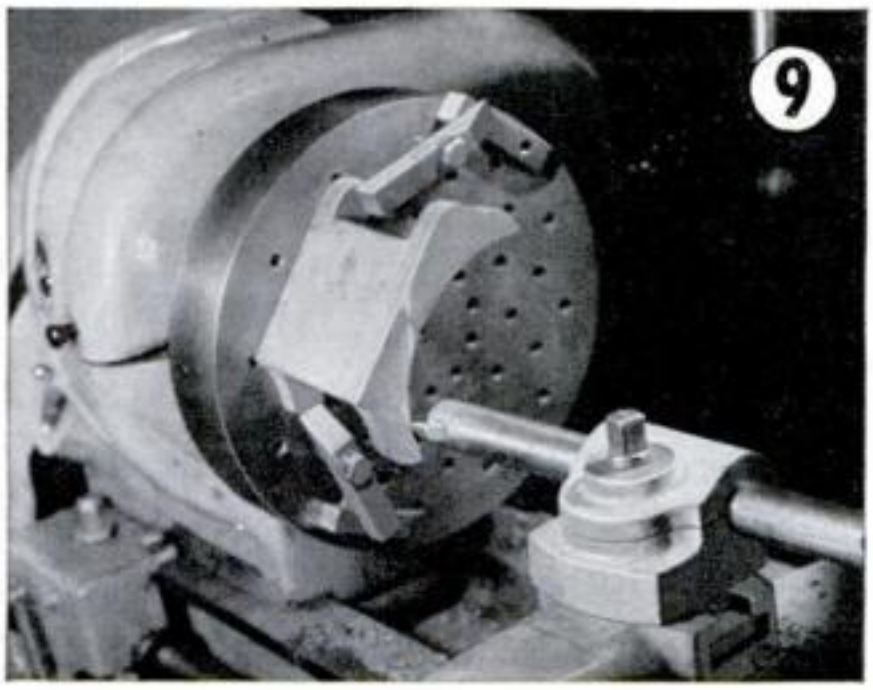
The casting for the motor base was clamped to the faceplate as shown in Fig. 9, and turned out to fit the motor housing. After the four bolt holes have been drilled, the base can be fastened to the motor as in Fig. 10.

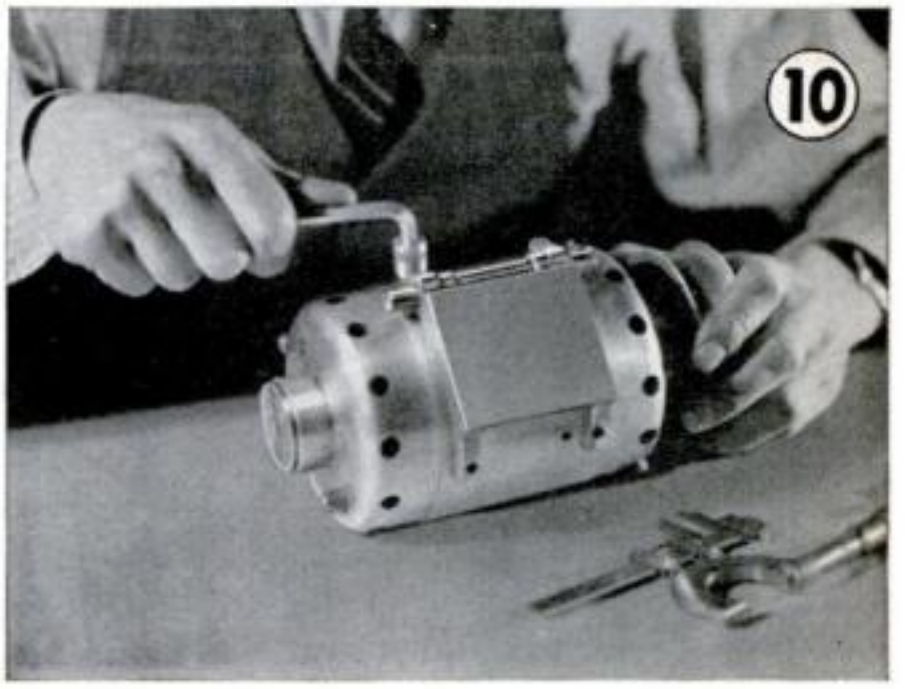
The mounting post was turned from cold-rolled steel and drilled to receive the ½" clamping bolt, which was made from steel rod by turning up a hexagon nut tightly on one threaded end and riveting that end over. The other end threads into the clamping shoe, made to fit the tool-post slot in the compound rest of the lathe. The clamp assembly is made from steel, as shown in the drawings. These parts finished, work can be begun on the quill and grinding spindle.

(TO BE CONCLUDED)

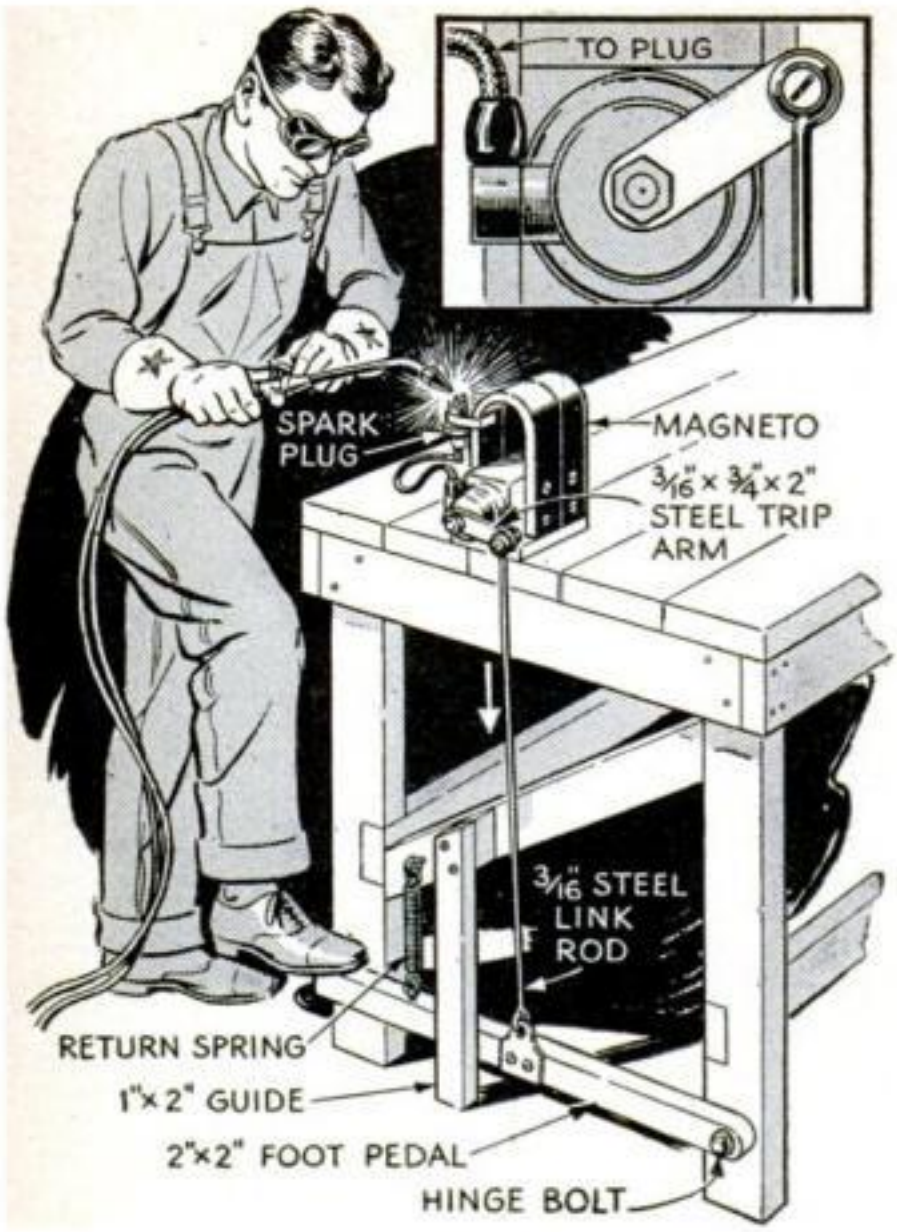


# Engine Magneto Mounted on Bench Lights Gas Welding Torch



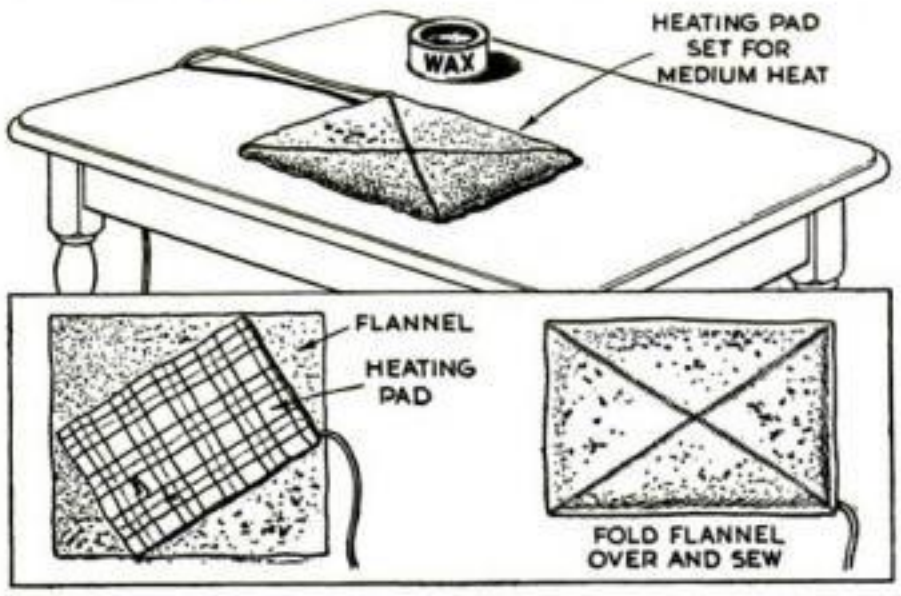

AN OLD magneto mounted either as shown or under the workbench can be used for lighting a gas torch. In this instance a magneto from a single-cylinder motorcycle was used. The trip arm must be set so that the magneto points break at about the halfway point on the down stroke, causing a spark at the spark-plug electrodes. Adjust the linkage for normal operation, and provide a pedal-return stop.—WALT LOVELL.

## Antislip Surface for Ruler

FRICTION tape applied to the underside of a ruler will prevent it from slipping when it is used on a smooth surface.—E. P.

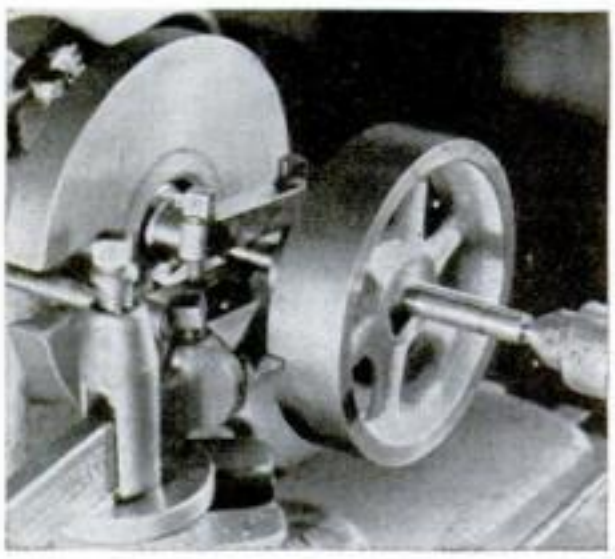
## Heating Pad Polishes Wax

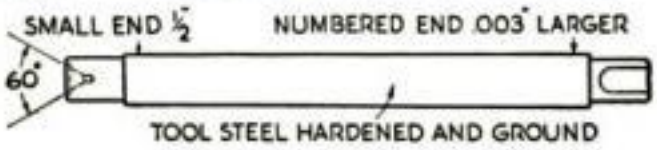
IN ONE showroom where much furniture has to be wax polished, time and labor is saved by using an electric heating pad covered with flannel. A thin coat of paste wax is applied and allowed to dry. The pad is set for medium heat and drawn slowly over the waxed surface.—EUGENE MORRISON.




## PLAIN MANDRELS

[ *LATHE WORK—15* ]






Mandrels are used to hold work that has been bored and reamed and that is to be further machined between centers in the lathe. The mandrel must be driven firmly into the hole so that the work will not slip under heavy cuts. For this reason mandrels are slightly tapered, one end being just under size, the other from 0.002" to 0.003" over size, depending on the length of the mandrel.

The size is always stamped on the large end. The accuracy of the mandrel depends largely on the condition of the center hole in each end. To avoid damaging these holes, use a soft hammer or a mandrel press to drive the mandrel into the work. The center hole at the tailstock end should be well oiled during use. If this hole should become scored, the accuracy of the mandrel will be impaired.

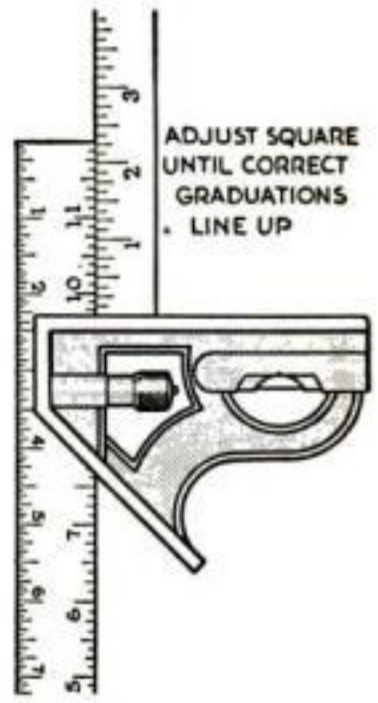
POPULAR SCIENCE MONTHLY SHOP DATA FILE

## Shop Coats and Overalls Kept in Empty Round Oil Cans

MECHANICS' shop coats or overalls and the seat covers used in auto service stations can be stored neatly in empty 2-gal. round oil cans, which are ordinarily thrown out. Cut one end of the can evenly very close to the rim and hammer the sharp edge smooth. Then drill two holes near the edge and screw the can to the underside of the workbench top, as illustrated. One shop where this method is in use has had to supply a number of the empty cans to customers, who liked the idea so much that they wanted to fasten such containers under their own benches.—LEO M. KNASKY.

## Setting a Combination Square with Vernier Accuracy

THE BLADE of a combination square may be set accurately within a few thousandths of an inch with the help of a steel scale, as shown. Place the scale alongside the blade with its end against the head of the square. Then adjust the blade of the square by tapping it lightly with a piece of wood until its own graduations, at the desired setting, coincide exactly with the graduations on the scale. This affords a vernier effect impossible by the use of the markings on the square alone. The scale used should be of a quality comparable to that of the square, as any discrepancy between the scales spoils the accuracy.—RAYMONDLEVY.



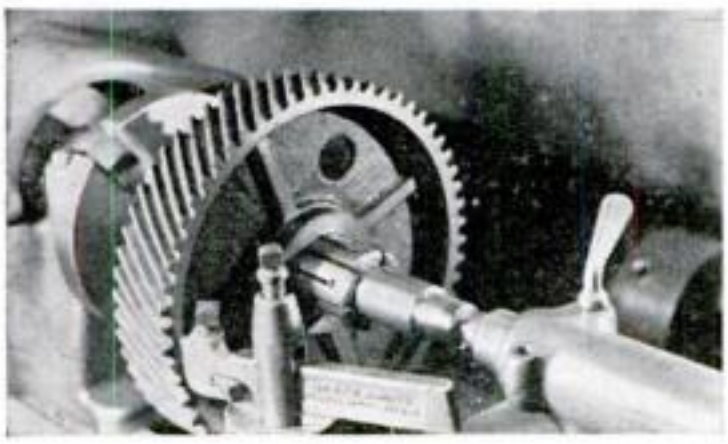

## Punch Marks Made Easier to Read by Using Carbon Paper

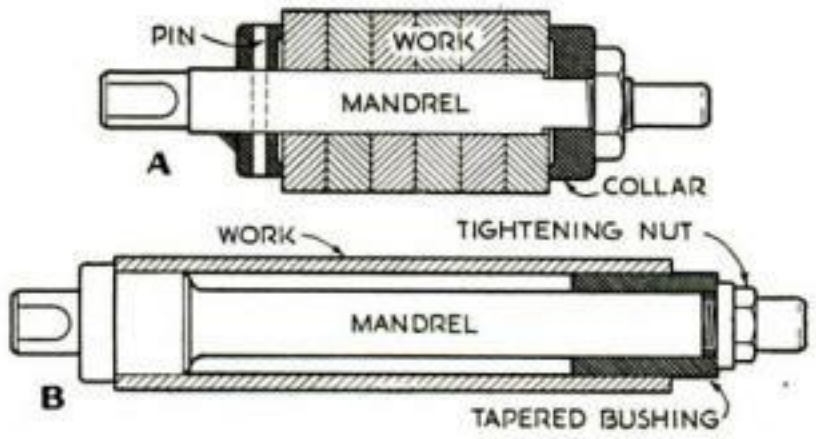
LETTERS and figures stamped on wood and other materials with steel punches are often hard to read. They will be more prominent if carbon paper or typewriter ribbon is put between the surface and the punch.—T. G. S.

## EXPANDING AND SPECIAL MANDRELS [ *LATHE WORK—16* ]

An expanding mandrel derives its holding power from the expansion of a loose split ring that fits into the work. The mandrel itself has a taper of ½" to the foot. The ring or sleeve has the same internal taper and expands as the mandrel is driven into it, thus gripping the work accurately and securely.

The most commonly used mandrel is the plain round type, but a great variety of special mandrels are made up for specific jobs. Two of these are shown. The one at *A* is a gang-type mandrel used for turning circular disks concentric with the hole. The one at *B* is for gripping long sleeves.






POPULAR SCIENCE MONTHLY SHOP DATA FILE

# ELECTRIC ENGRAVING TOOL

By HAROLD P. STRAND

ONE of the handiest small tools for home workshop use is the electric engraving pencil illustrated in Fig. 1. It is easily built and costs very little. It will engrave name plates, initials, and designs and do fancy tooling on such materials as brass, copper, and plastics.

In addition to its use for engraving, it would make an excellent heavy-duty signal buzzer to work directly on a lighting circuit without a transformer. If a rubber suction cup is fitted to the armature in place of the engraving bit, the tool may be used as a massage vibrator. The device is designed to operate on 110-115 volts A. C., and draws only a small amount of current. Having no contacts to burn or pit, it should last a long time.

Fig. 2 (top). An old radio transformer supplies the core pieces. Cut them carefully, keeping ends of the legs square

Fig. 3 (center). To align the core laminations, clamp them together and hammer them gently against a flat iron surface

Fig. 4 (directly above). The magnet core assembled. The armature and its bracket are shown held in place by a single screw

Fig. 5 (right). The coil is wound on a wooden form slightly larger in cross section than the center leg of the core

The core is made of laminations taken from an old radio transformer. The size of these is not critical, but should approximate the dimensions given. The old winding is removed from the transformer and the separate pieces of core iron are cut as shown in Fig. 2 to form E-shaped laminations.

All the pieces are then assembled and clamped together with two small C-clamps (Fig. 3). The pile is squared up by placing the assembly pole ends down on a flat piece of iron and tapping the laminations with a small hammer.

For the armature, a piece of ½" by ⅛" cold-rolled steel is used. This is attached to the bracket with rivets, countersunk on the underside. The bracket is fastened to a piece of flat stock bent over to form an "L," rivets being used for this also. The material for these pieces is ½" by 1/16" cold-rolled steel. The bracket is secured to the core by 6-32 screws and nuts.

On the extreme end of the armature a shouldered stud is riveted, and a hole is drilled through it and tapped 6-32. This stud adds weight to the trip-hammer blows of the armature, and in addition provides a rigid mounting for the engraving bit.

The assembled core and armature are shown in Fig. 4, with a single screw temporarily holding the parts together so that their alignment may be checked. A single rivet can be seen passing through each leg of the core near the top ends to hold the laminations together. In the final assembly screws will clamp tightly the other parts of the core.

The coil consists of 2,000 turns of No. 30 enameled magnet wire, wound on a wooden form clamped in the chuck of a breast drill (Fig. 5). Two turns of varnished cloth are

Fig. 1. This tool will work soft metals, plastics, and similar materials. Here it is being used to engrave a brass table stand

Fig. 6. After the coil is wound, it is taken off the form, and the temporary cotton ties are replaced one at a time with friction tape

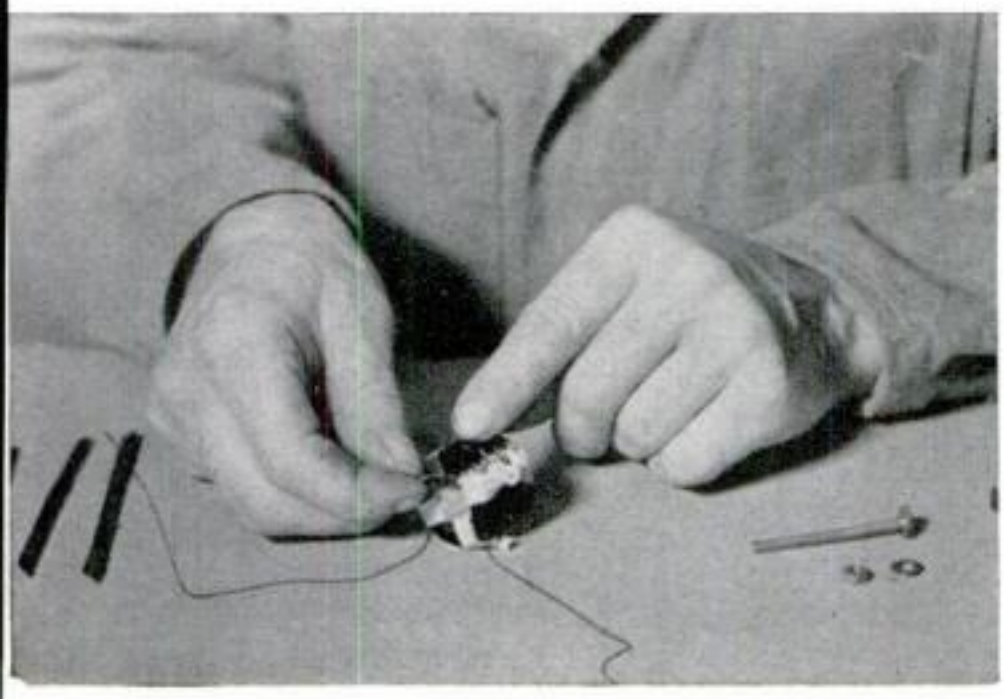
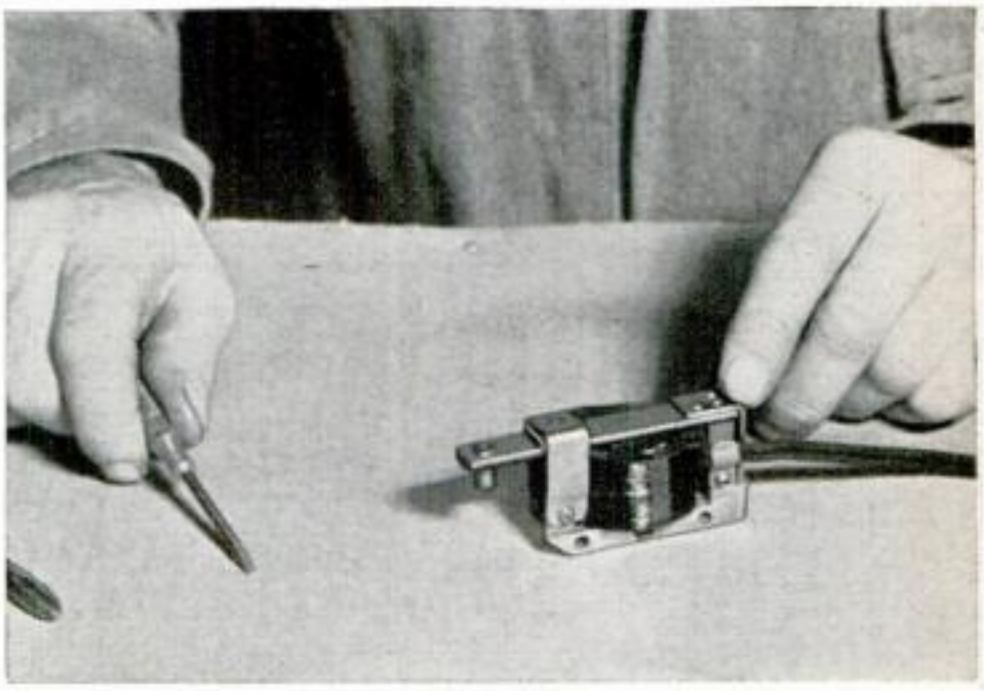


Fig. 7. The assembled parts are here shown ready to receive the case. A small brass clip fastened under one screw holds the electric cord securely



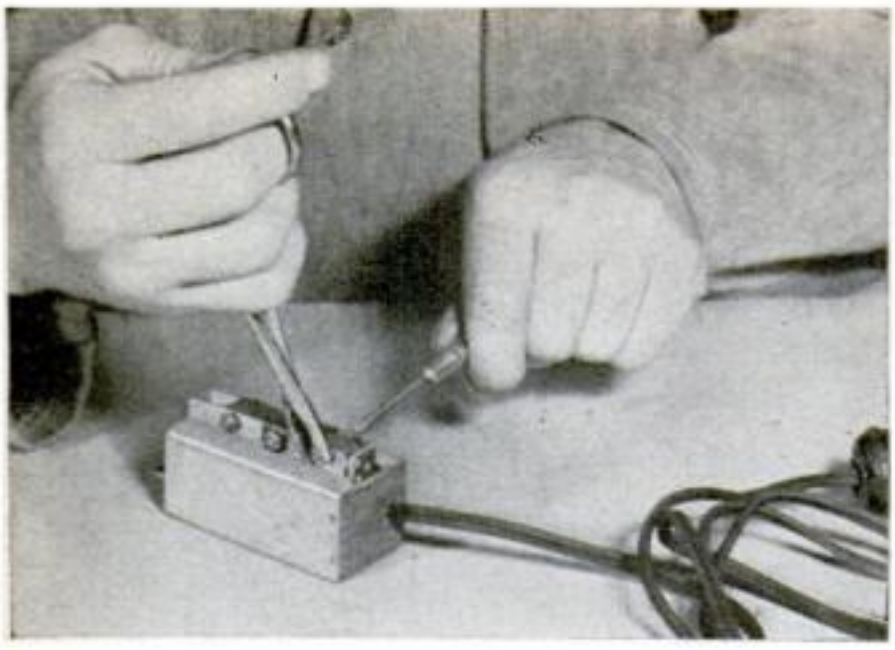


Fig. 8. The case, bent from thin sheet metal, is attached with two small machine screws and nuts

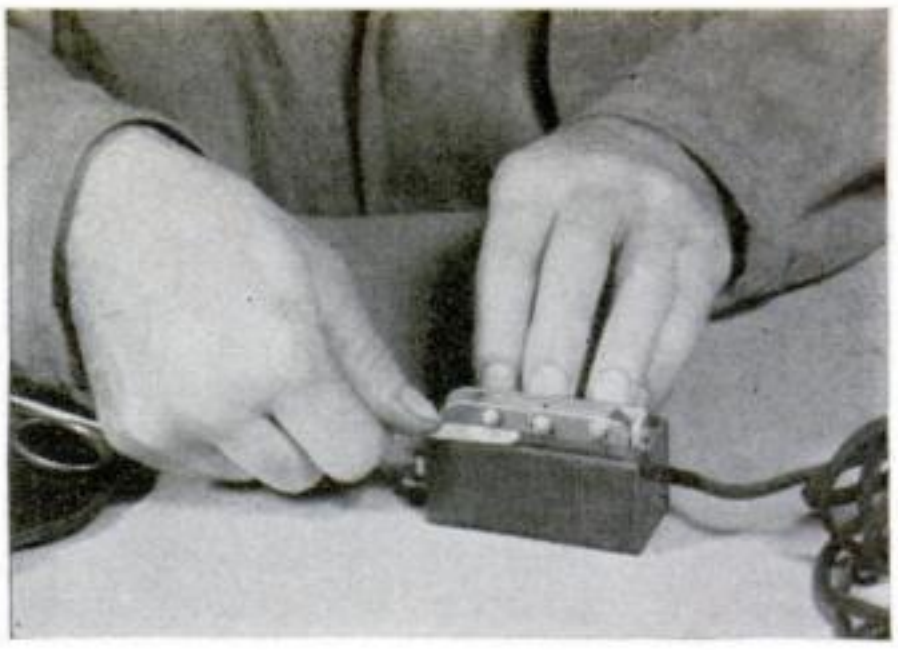


Fig. 9. Shellac is used as an adhesive in covering the case with leather from an old pocketbook

wrapped over four strips of cotton tape on the square spacer block. The wire is wound over the cloth, the turns being kept as flat and even as possible.

After winding, the cotton tapes are tied over the coil so that it can be removed from the form. The cotton tape is then replaced with friction tape, one piece at a time (Fig. 6). This makes for a neater appearance than the knotted cotton strips.

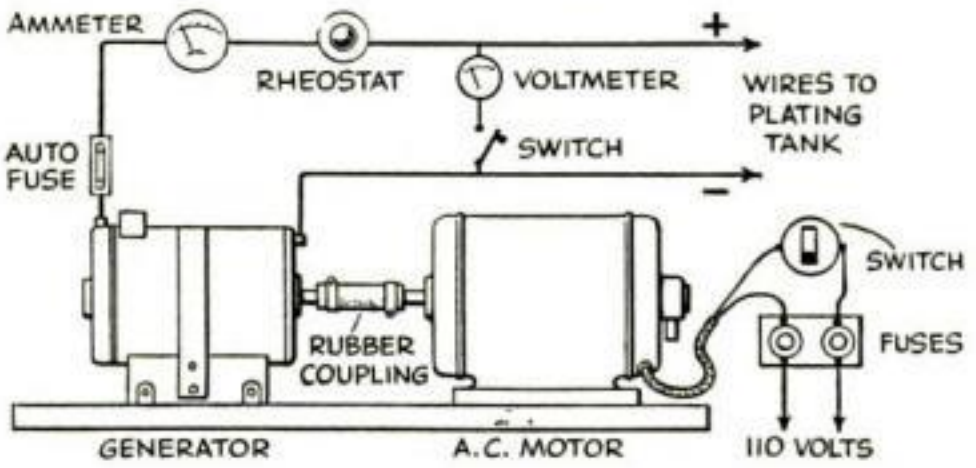
The completed coil is slipped over the center leg of the core, with thin fiber washers, cut to the same diameter as the coil, at the top and bottom to keep the end turns from touching the core. Thin hardwood wedges are used to keep the coil in place by squeezing two or more, as required, between it and the core. Some thick shellac allowed to run down inside the coil affords another good method of holding it in place.

A clip is bent from some brass stock, to hold the rubber cord, and a U-shaped piece is made from some of the ½" by 1/16" steel stock to fit over the armature. This guide has a rubber insert, which acts as a shock absorber. The rubber is held in place with a single rivet. The holes through the legs of this piece are slightly elongated to allow for adjustment of the armature. Experimentation will show the proper clearance between the armature and the pole pieces for best performance. When this is found, the screw is tightened, with a lock washer back of the nut (Fig. 7). The ends of the rubber cord are soldered to the ends of the coil and the joints taped.

The case is formed of 28-gauge galvanized iron, which is easy to work, and is closed at one end with a piece of 3/16" oak or other hardwood, through which a hole is

## ELECTROPLATING, PART 4 [*ELECTRICAL*]

Only *direct current* can be used for electroplating. Ordinary No. 6 dry cells are suitable for plating small pieces of jewelry. For larger work use a storage battery, an inexpensive battery charger, or a small motor-generator unit. A very practical motor-generator outfit can be built from an old ¼-h.p. washing-machine motor and an automobile generator. Place a rheostat, such as a heavy-duty radio filament rheostat, and an ammeter in the circuit as shown to control the current accurately. Install a voltmeter so it can be used across the tank supply wires by means of a single-throw switch. Rheostat and meters are used in the same manner with any other type of current supply.

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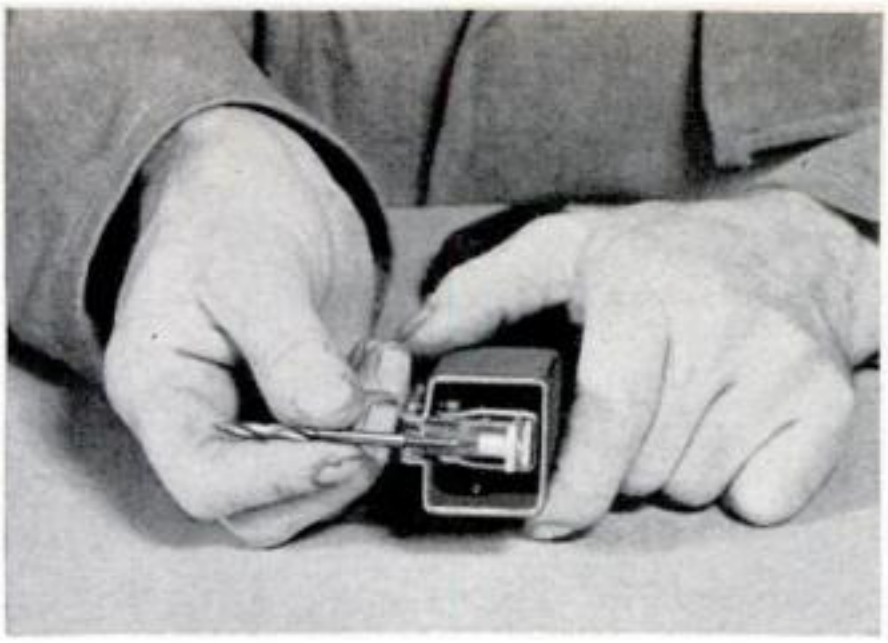


Fig. 10. Twist drills ground to a point make good engraving bits. Thread shanks to fit the socket

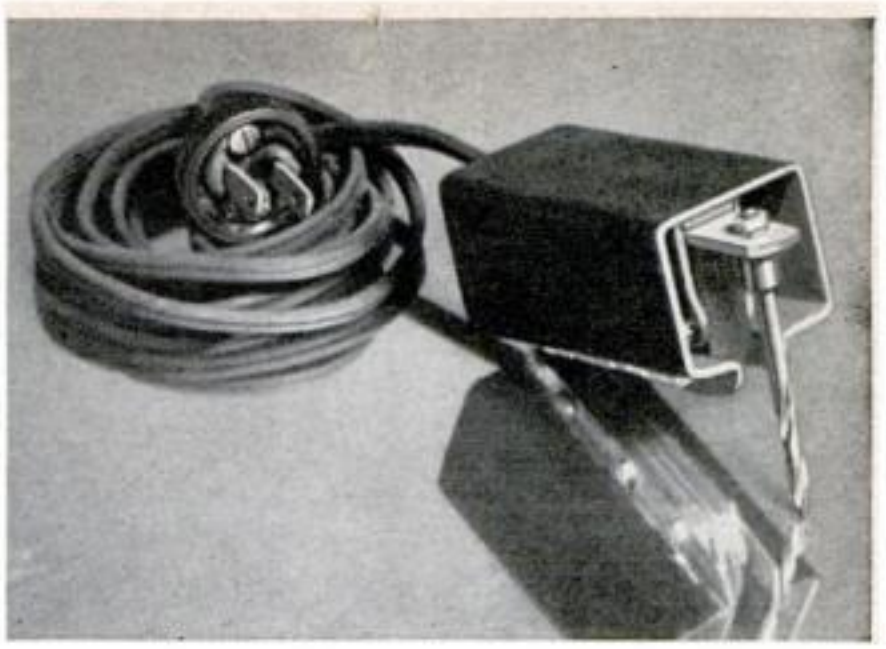


Fig. 11. The finished engraving tool. To use it, hold as shown in one of the previous photographs

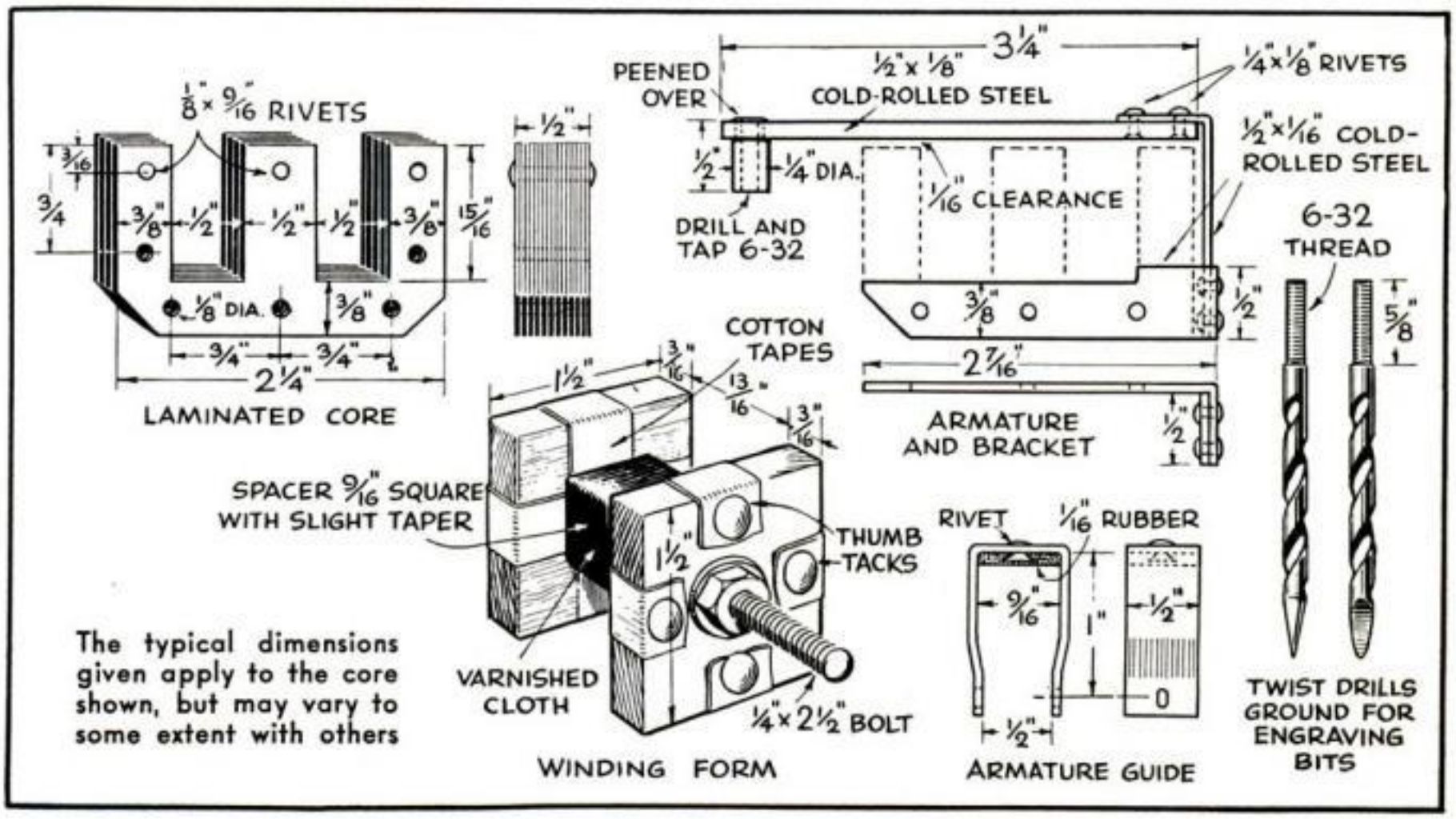
bored for the cord. This end is held in position with some small flathead brads. A slot is made to clear the center bolt, and two additional 6-32 screws are used to hold the case on (Fig. 8). These also help to clamp the laminations.

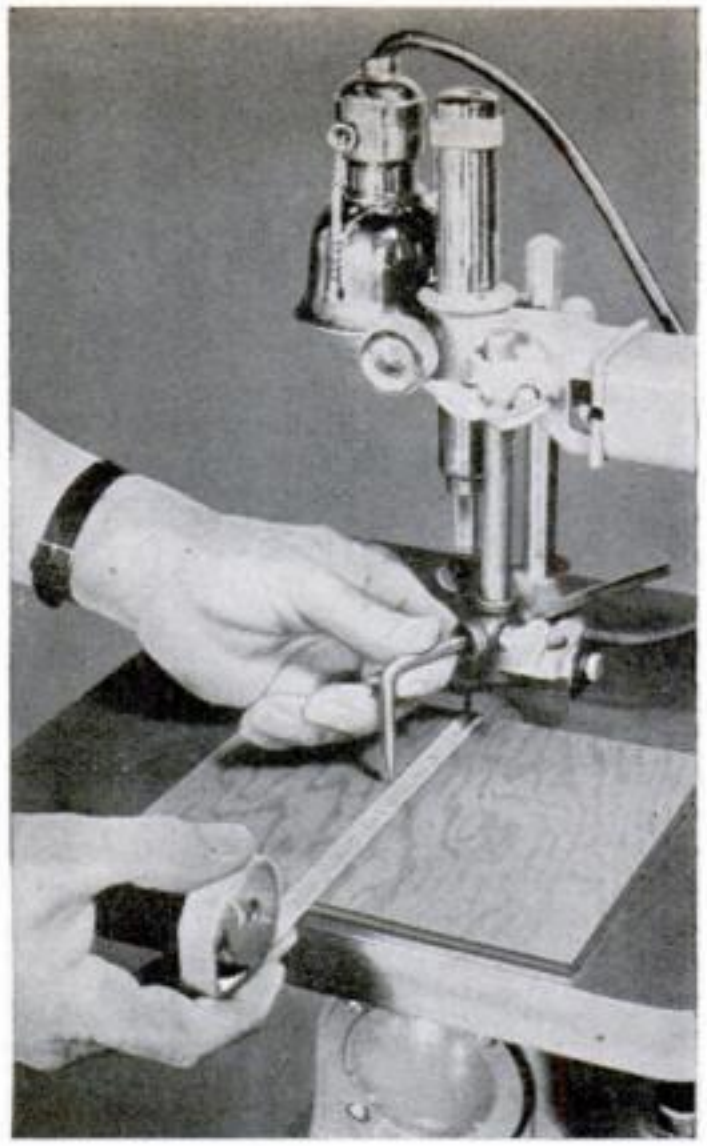
The case may be covered with leather taken from an old pocketbook (Fig. 9). Thick shellac or liquid glue is brushed on the leather and allowed to dry until tacky. The material can then be applied to the case. Rub the surface well to smooth out the leather and make it adhere firmly.

The engraving bit can be made from drill rod, but if this material is not at hand, a 5/32" twist drill will do and has the advantage of being already hardened (Fig. 10). Grind the end to a sharp point. Different points can be ground on other bits for special uses.

The shank ends of the bits, if hardened, are annealed. It may be desirable to wrap a damp cloth around the sharpened end of the bit when heating it, to avoid drawing the temper from that part. Then, after the diameter of the shank has been reduced slightly by grinding, a 6-32 thread can be put on for a distance of 5/8". This permits the bit to be screwed into the stud on the armature. A nut and lock washer are used on top to keep the bit from working loose under vibration.

To use this tool, exert only slight pressure on the bit, especially at first, until you have learned to hold it to the best advantage and are able to guide it steadily. This will come with practice. Keep the points on the bits sharp on a fine cutting wheel. Try various types of points until the one best suited to the work in hand is found.





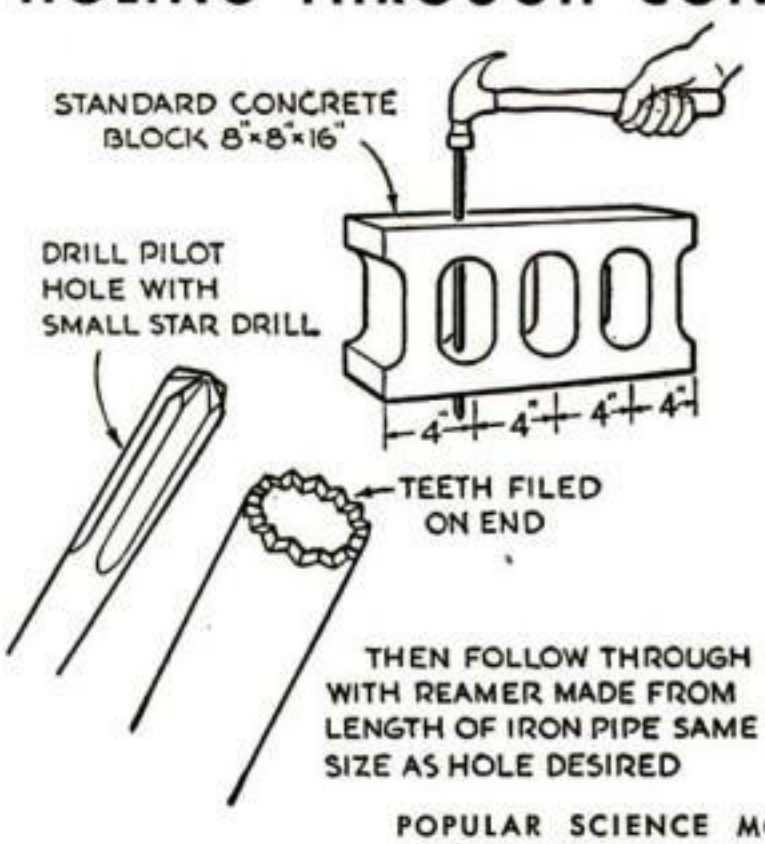
## Disks Cut on Jig Saw with Aid of Adjustable Pivot Point

SCROLL saws like the one illustrated can be adapted to cut disks by means of the jig shown. This is a piece of ½" diameter brass, iron, or steel rod 5¼" long, threaded at one end 7/16"—14. Tap the center connection of a ⅛" pipe tee to fit the threaded rod and screw the two pieces together.

Bore and tap a hole in the side of the tee to receive a ¼" thumb screw for locking the round pivot arm in the tee. The arm is ¼" in diameter and 8" long, with a 2" bend, the end of which is ground to a point. File the rod flat on the thumb-screw side so that it cannot turn when locked.

The jig is held by means of a thumb screw as shown, and the point set on a line at right angles to the flat of the saw blade to cut whatever size disks are desired.—F. H.

## HOLING THROUGH CONCRETE BLOCK [MASONRY]




Straight, clean-cut holes can readily be made in concrete-block walls for the installation of water pipes and wiring conduits if the holes are spotted so that the drill will pass through the center of the cores (hollows) in the blocks. This reduces work to a minimum and lessens the risk that the drill will be turned aside by the curved core wall. Cores can be located by measurement once the type of block to be pierced is known. This can often be found by inspecting the foundation or the top of a wall. A common type of block is shown, but others of this size may have a different core arrangement.

Rotate the reamer while driving it.

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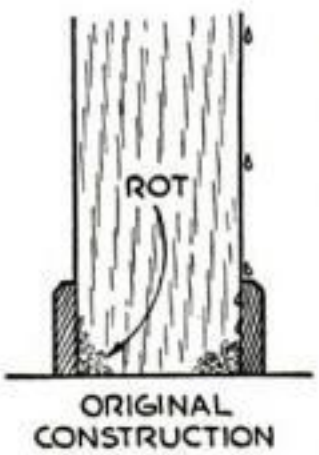
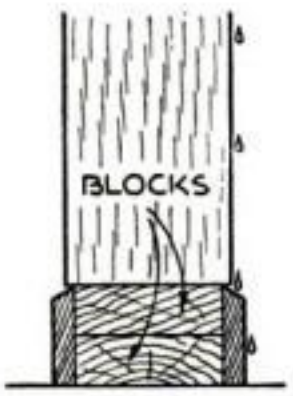
# Base of Old Porch Pillar Repaired in Order to Prevent Rotting

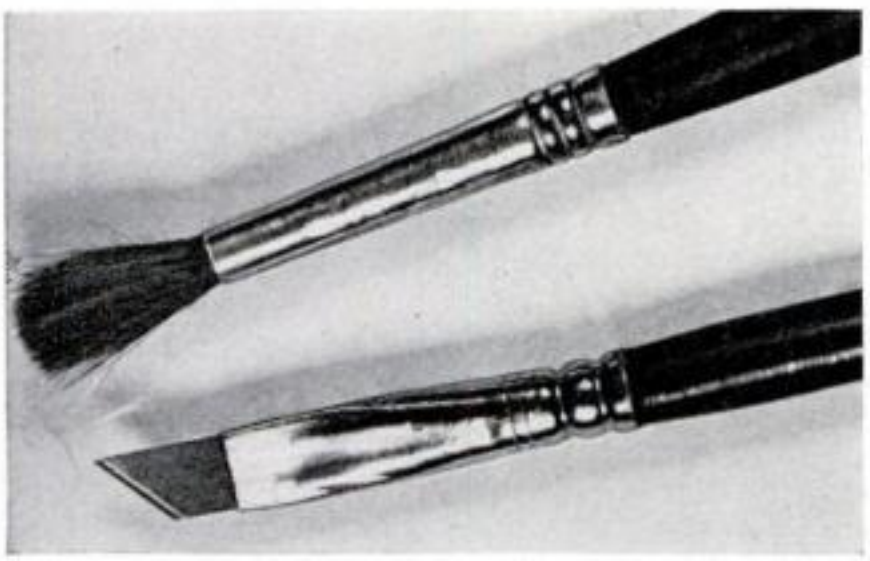
IF A PORCH pillar that has become rotten at the base is repaired in the manner shown here, the new base will be protected from rain water and will resist rotting better than did the original. Saw off the rotted end at a height equal to that of the base molding. Cut replacement blocks about ⅛" smaller than the cross section of the pillar, and insert them as in the photograph. Bevel the top edge of the molding all around, and fit it into the shallow recess as shown in the lower drawing, so that the joint between the molding and the supporting blocks comes under the pillar proper. The beveled molding will shed rain water that runs down the column, and prevent its seeping into the joint between base and molding, as it formerly did.—J. M.




ORIGINAL CONSTRUCTION




REPAIR CONSTRUCTION



## Old Water-Color Brush Serves as Handle of Stencil Knife

A FRISKET or stencil knife that has the same "feel" as a brush in an artist's hands can be improvised from a safety razor blade and a discarded water-color brush. Burn out the bristles, fill the hollow in the ferrule with warm sealing wax, and flatten by squeezing gently. Insert a piece of a razor blade, then squeeze the ferrule over it. Shape blade on a wheel, and hone it on an oilstone. To insert a new blade, soften the sealing wax in boiling water.—ROBERT BLICKENDERFER.

## Adding New or Special Marks to a Plain Rubber Stamp

SMALL figures, ornaments, symbols and the like can be added to rubber stamps by cementing on ordinary tire-patching rubber cut to shape with embroidery scissors. The illustration below shows how decorative dots, made with a leather punch, were added to improve the appearance of a stamp impression. If a border is desired around the stamp, use a paper trimmer to cut the rubber into narrow strips.—CLIFFORD LEESTMA.

# Simple Home Experiments Show Why the Weather Behaves the Way It Does

WHEN "highs" and "lows" march across the country, that's weather, to the professional forecaster. But to the average man, weather is a matter of fresh or wilted collars; a beautiful summer day, or a downpour that drenches his clothes; a good time to go fishing, or to stay home.

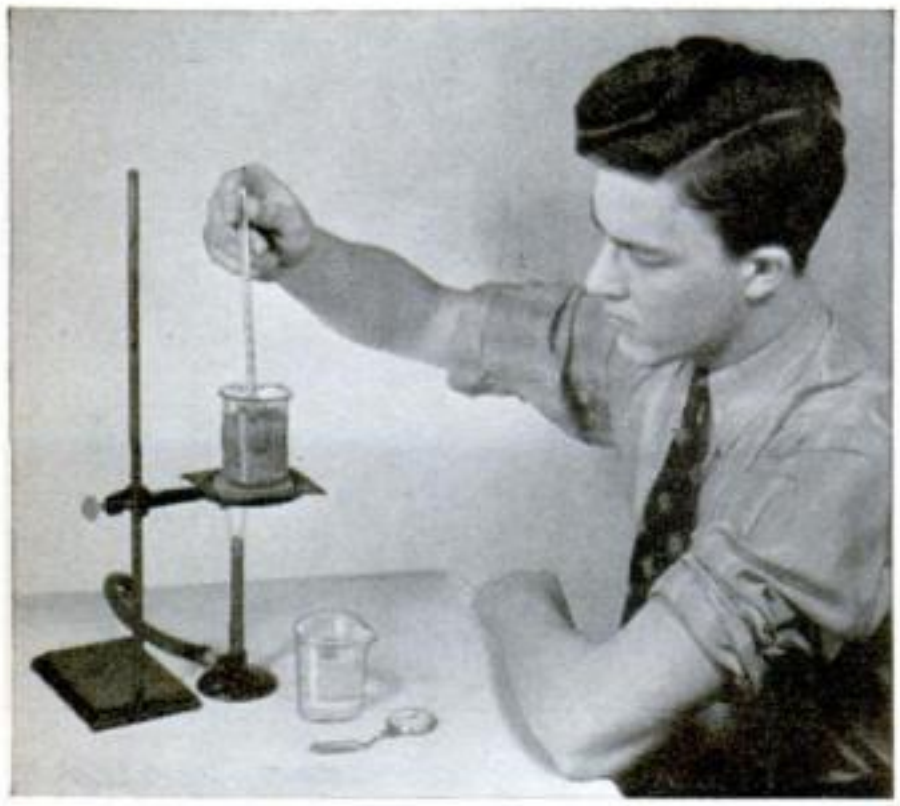
Here are a few easy home experiments

**PERSPIRATION KEEPS YOU COOL.** If you doubt it, wet your hands and place them in a hot breeze, blown through a toaster by an electric fan. Your hands will feel cooled as long as they are moist. When they are dry, they will be heated. Evaporation of water, or of perspiration, gives the cooling effect.

**HOW SMOKE FORETELLS STORM.** Drop burning paper in a bottle and quickly stopper it. The smoke will rise or fall, as pressure changes alter its buoyancy, if you blow or suck through a tube piercing the cork. Similarly, falling chimney smoke indicates reduced barometric pressure and a likely storm.

**TEMPERATE CLIMATE NEAR WATER.** Note the comparative time required to heat equal volumes of soil and water 20 degrees. Also compare their cooling rate. You will find that the water heats and cools more slowly. This explains why seashore climates vary less than those of places inland.

**LIGHT CLOTHES ARE COOLER.** With drops of candle wax, attach outstretched arms to cut-out figures of black and white paper. Exposure to a hot desk lamp makes the black figure drop his arm first, as shown below. The toys show that dark clothes absorb heat, while light ones reflect it away.



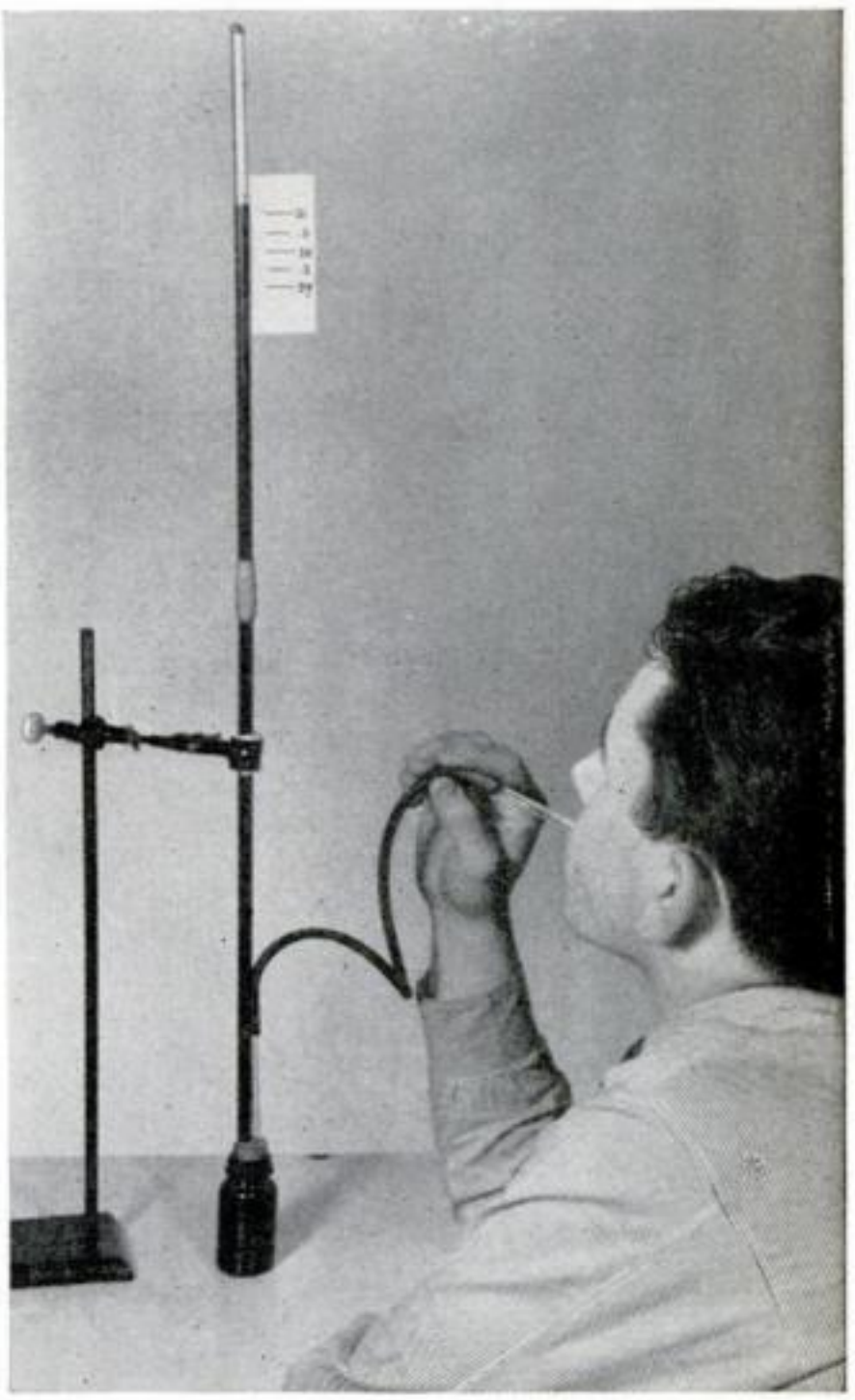
that help to illustrate why the fickle weather behaves as it does. Among them, too, you will find hints for keeping cool in hot weather, and for doing a little amateur weather predicting.

Even the simple homemade barometer described here, for example, will prove an instrument of very fair accuracy, if you provide it with a scale carefully calibrated by comparison with simultaneous readings of a standard mercury or aneroid barometer. With a small tube, the surface or meniscus of the mercury column will be noticeably curved, and the reading customarily is taken from its top.

Did you ever wonder why the wind blows? You'll find one of the reasons below. To the explanation, it might be added that what goes up must come down; the rising column of warm air eventually mushrooms out, cools, and descends to earth to complete the cycle of its circulation.

**FINDING THE DEW POINT.** Stir cracked ice and water, with a thermometer, in a polished metal cup. When mist forms on the outside, read the temperature. This is the "dew point" at which rain falls, dew forms, or cold-water pipes "sweat," because water vapor in the cooled air condenses.

**WHAT MAKES THE WIND BLOW.** If some part of the surrounding territory is hotter than the rest, you will notice a cool breeze. This consists of surface air rushing toward the spot, to replace heated air rising there. A table lamp and smoke from a cigarette or burning paper will demonstrate the phenomenon.

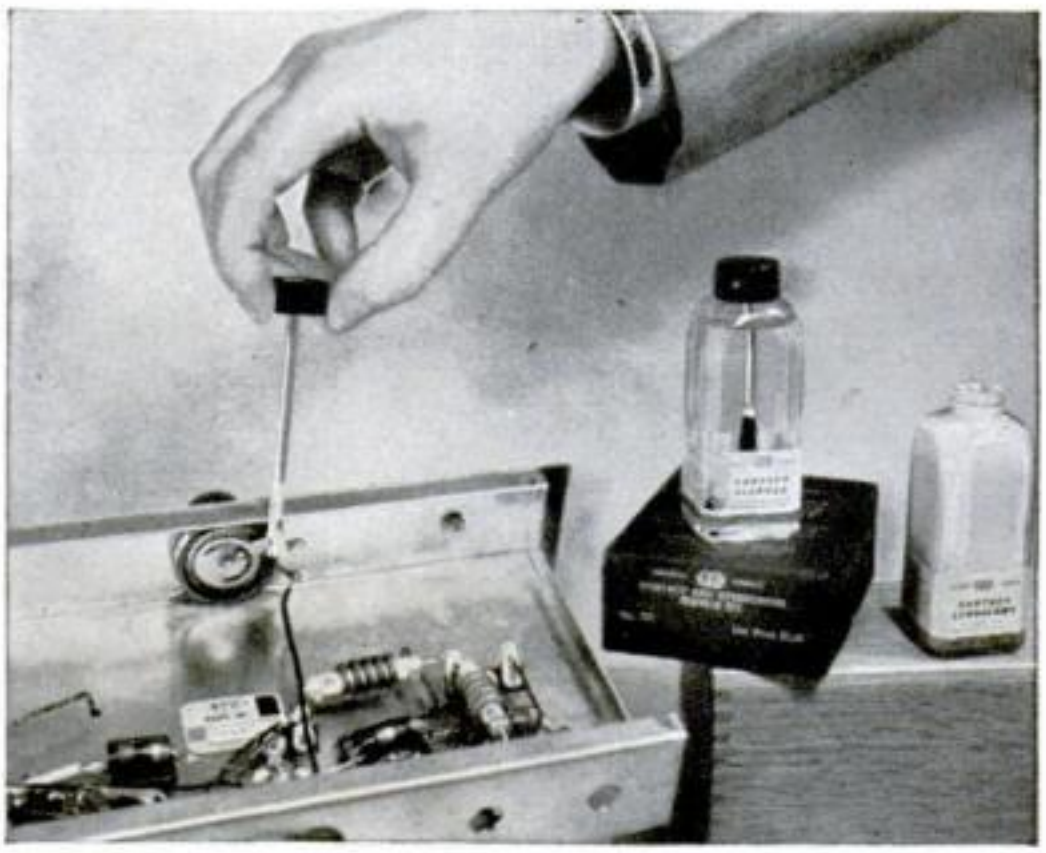


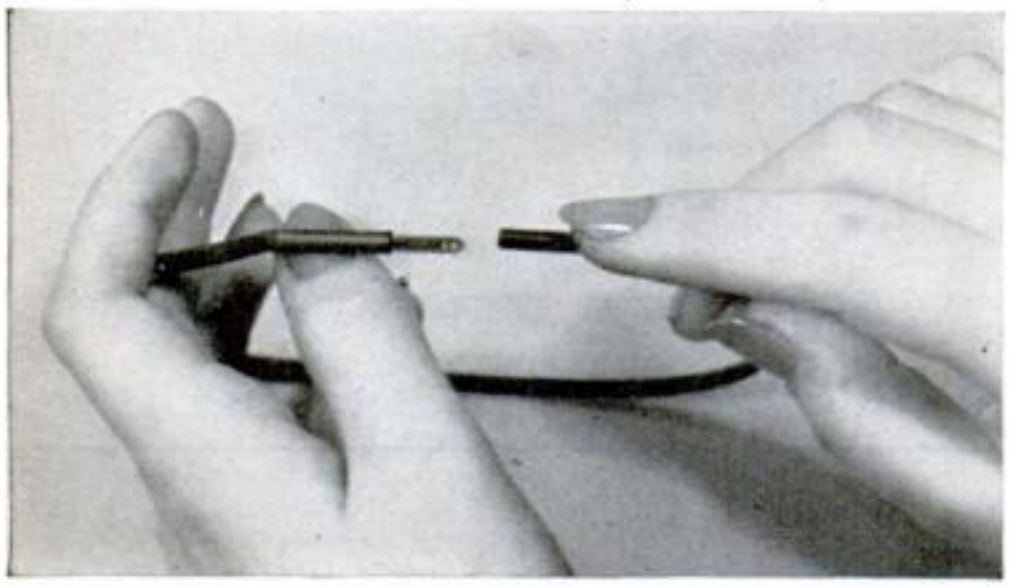
**HOMEMADE BAROMETER.** Fill a 34-inch glass tube, sealed at one end, with mercury. Fit the tube with a two-hole stopper and invert it in a small bottle. The mercury will drop until it stands about 30 inches high, supported by atmospheric pressure. To show its response to pressure, blow or draw in air through the second hole in the stopper. The column will rise or fall.

# Radio Ideas

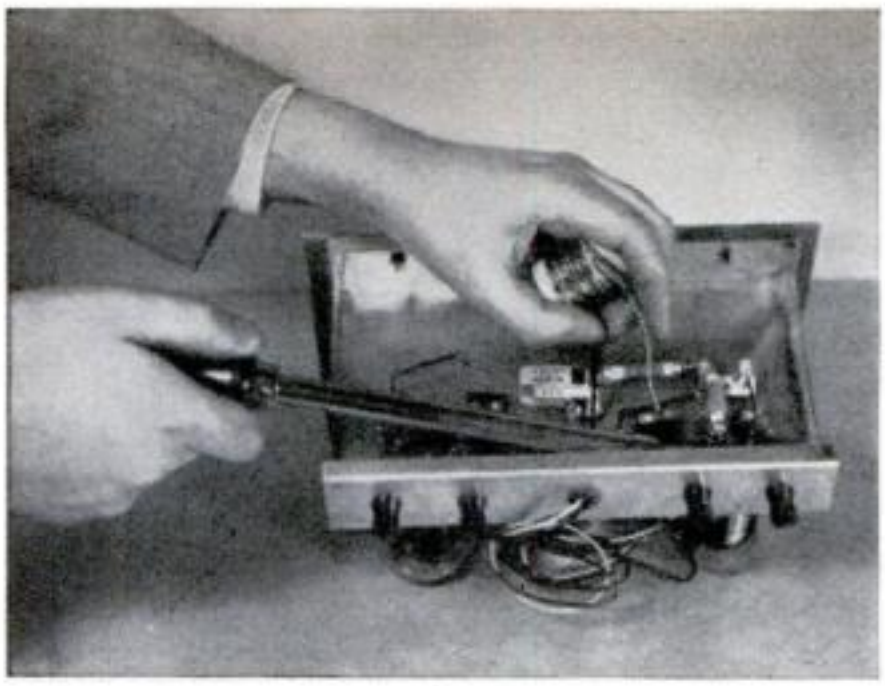
**SIGNALS FOR PRACTICE** in transmitting and receiving code messages can be obtained from this six-tube communications receiver by merely connecting a telegraph key in series with the headphones. When used for this purpose, the output of the set is a heterodyne whistle which is broken up by the key into a good imitation of the sound of regular radio code transmission. In addition, the set will receive code and phone broadcasts throughout a range of 545 kilocycles to 30.5 megacycles.

**CONTACTS** in wire-wound volume controls, attenuators, rheostats, and other electrical and radio units operate quietly and efficiently after treatment with the materials in a kit now on the market. It consists of a bottle of contact cleaner and another of contact lubricant. The cleaner is applied first, to remove dirt and corrosion from the contact surfaces. Then the lubricant is applied. This liquid forms a film over the surfaces which prevents rust and corrosion but does not offer any resistance to the passage of electric currents. Both bottles have brushes built into the caps.

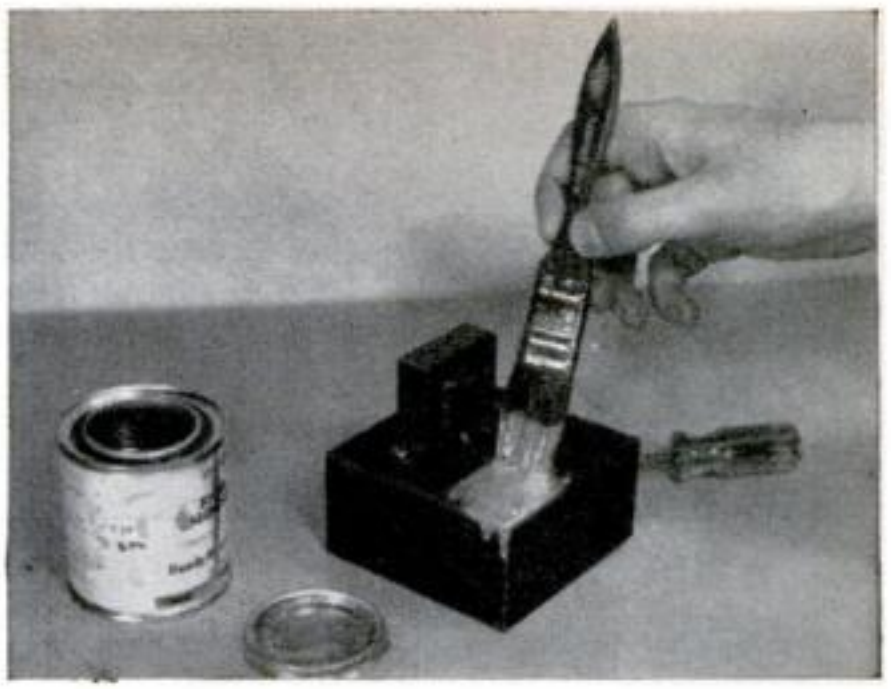




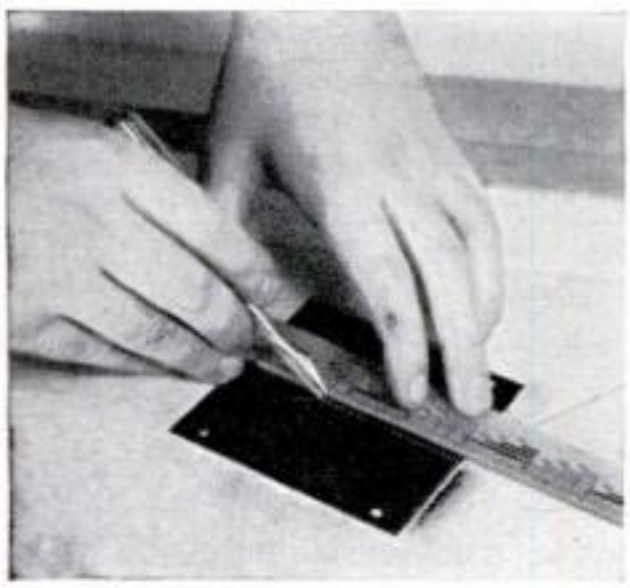
**DIAL BELT.** Here is a belt that can be installed without removing shafts or pulleys from the set. It has a flexible core to prevent stretching, and this is rubber-covered to avoid short circuits. It is fitted with a patented fastener, the parts of which need only to be shoved together to join the ends of the belt, eliminating the need for tying knots and adjusting springs. The belt is available in various lengths ranging from 6¾ to 22¾ inches.



**NONCORROSIVE SOLDER** of a new type manufactured in England and approved by the British Air Ministry uses three separate cores of flux instead of the customary one. It is claimed that this eliminates the possibility of there being no flux in a portion of the solder, and avoids "dry" joints with high electrical resistance. Proportion of flux to solder is the same as with one core.



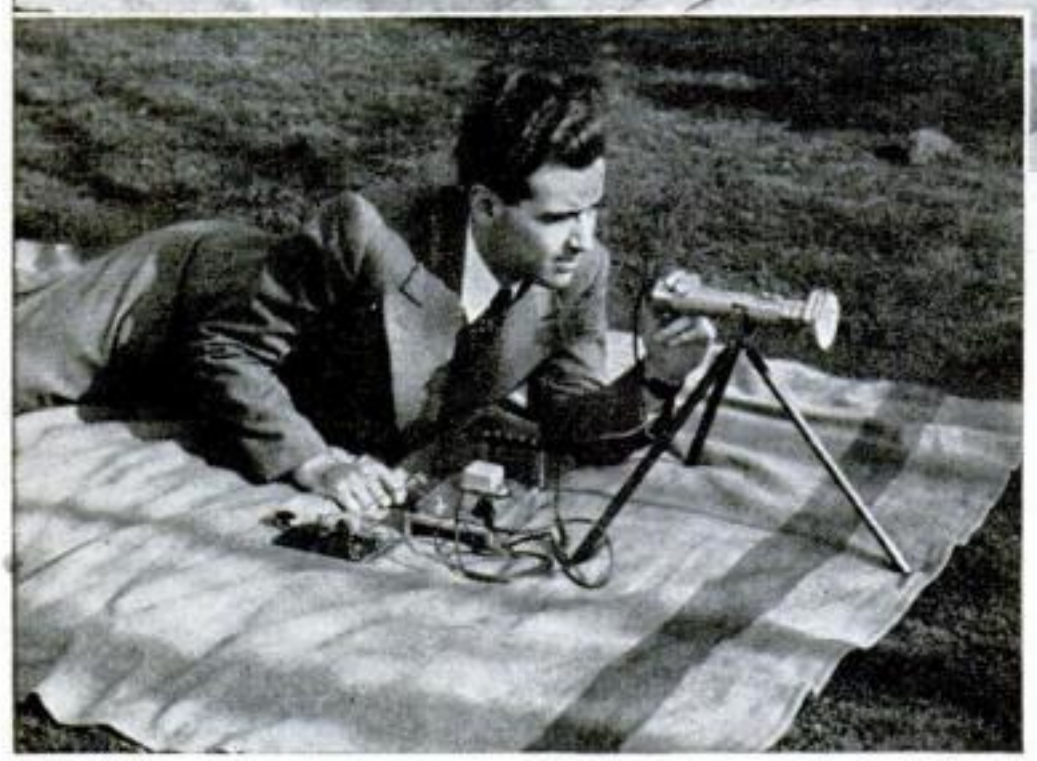
**A CHROMELIKE FINISH** can be applied to homemade radio chassis, mike stands, and public-address equipment with a new aluminum paint. It comes ready-mixed, and may be applied with either brush or spray. According to the manufacturer, it dries in 30 to 40 minutes, leaving a brilliant enamel finish resembling chrome. The paint is sold in cans ranging from ⅛ pint to a gallon.



Marking a metal plate. Sharpened edges give the tool many uses

**DRIVING SCREWS** is but one of the uses of this versatile tool-steel screw driver. By beveling the sides of the tip and grinding them to produce sharp edges, the manufacturers have produced a tool which can be used for wire skinning, reaming, countersinking, scraping, and marking wood, metal, or plastic surfaces. It is fitted with a nonconducting plastic handle which makes it safe for working around live wires. Including the handle, its length is 5¼ inches.

**IDEAL FOR THE SMALL HOUSE** or apartment where space is at a premium is this small electric phonograph. The walnut cabinet containing the motor, speaker, and three-stage amplifier measures only 11¾ by 9 by 5¾ inches. The motor is self-starting, air-cooled, and runs the 9-inch turntable at a constant speed of 78 revolutions per minute. Either 10 or 12-inch disks can be played on it. For accurate reproduction, a high-quality crystal pick-up mounted in a true-tangent arm is used. The 3-inch permanent-magnet speaker can handle a 2-watt output.



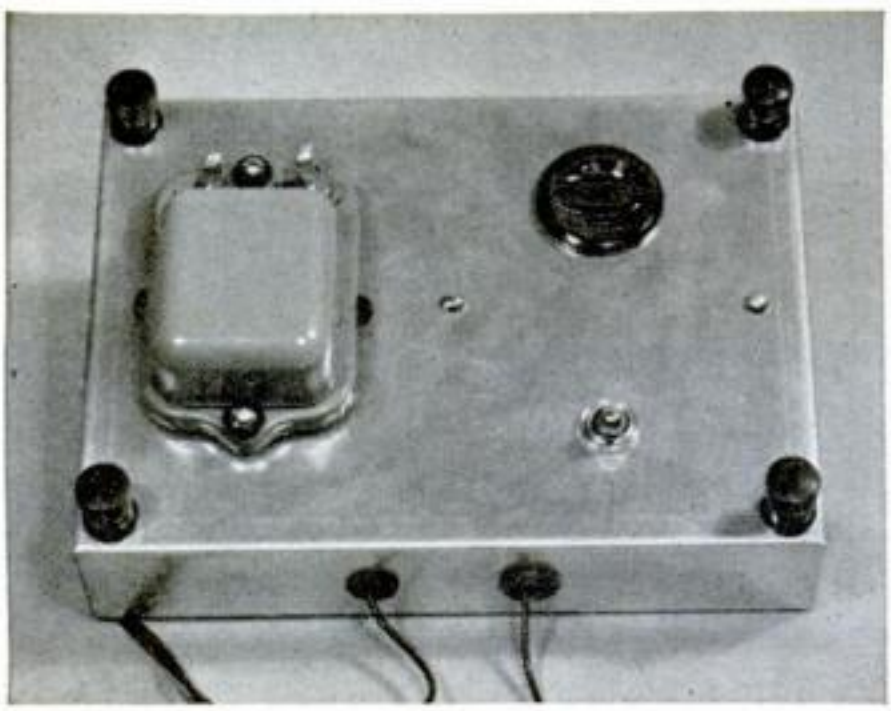
The operator taps out a code message on an ordinary telegraph key. Below he sights along the barrel to aim the flash light

# LIGHT-BEAM TRANSMITTER

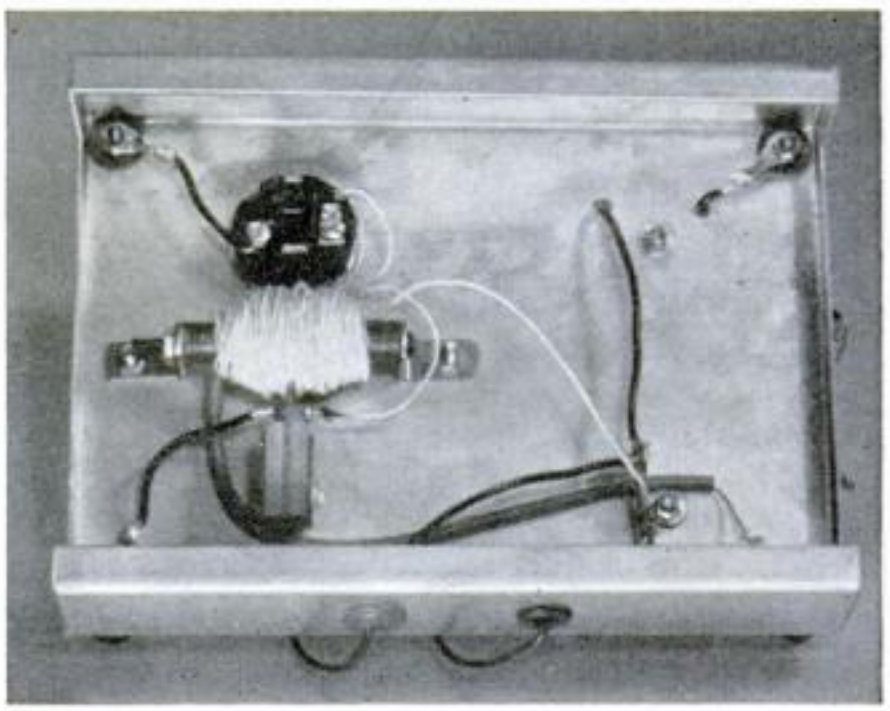
By ARTHUR C. MILLER

CODE MESSAGES that can be detected only with a specially built receiver may be sent with this light-beam transmitter. With a 3- or 4-cell flash light, preferably of the type with which the light rays can be focused into a spot, messages can be sent up to 200 feet. By increasing the voltage of the buzzer circuit from 7½ to 22½ volts and using a more powerful light, this range can be increased.

The transmitter works on the same principle as a radio broadcast transmitter. The light waves from the flash light act as the carrier wave, and the code signals tapped

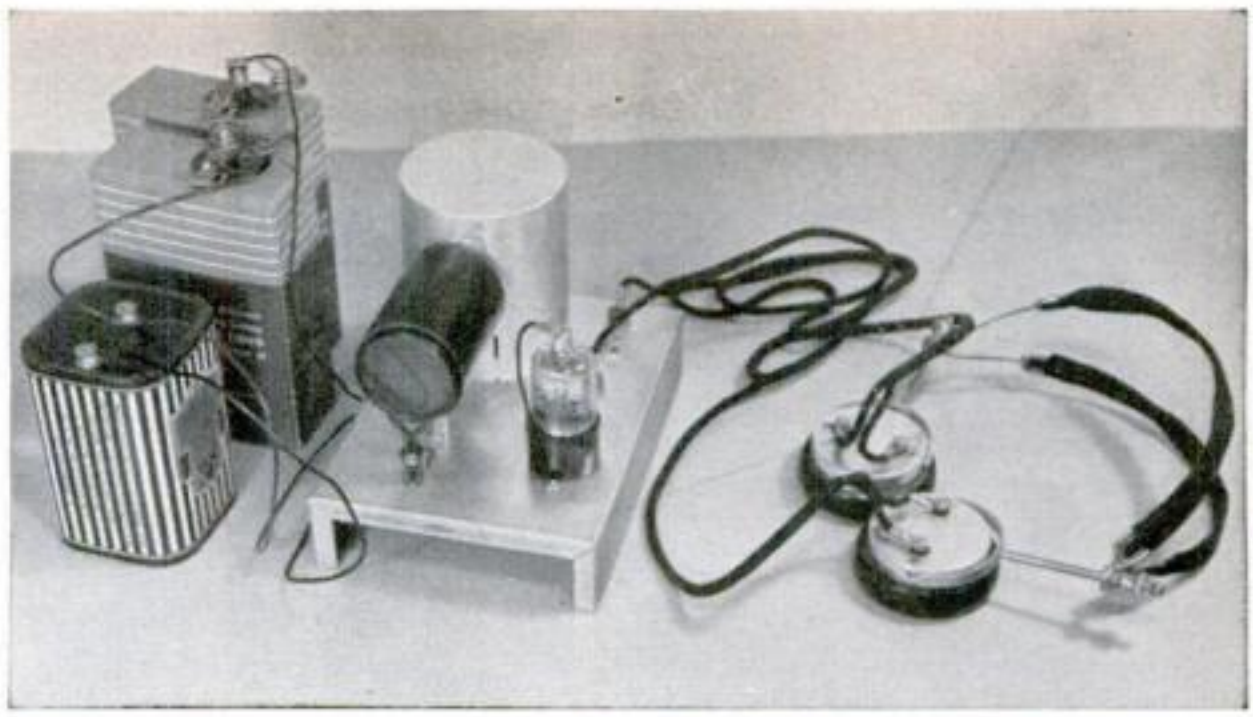


The top of the transmitter. Note rubber grommets



Bottom view shows handmade coupling transformer

The receiver, showing the photo-electric cell shield and the magnifying glass, connected by a black tube

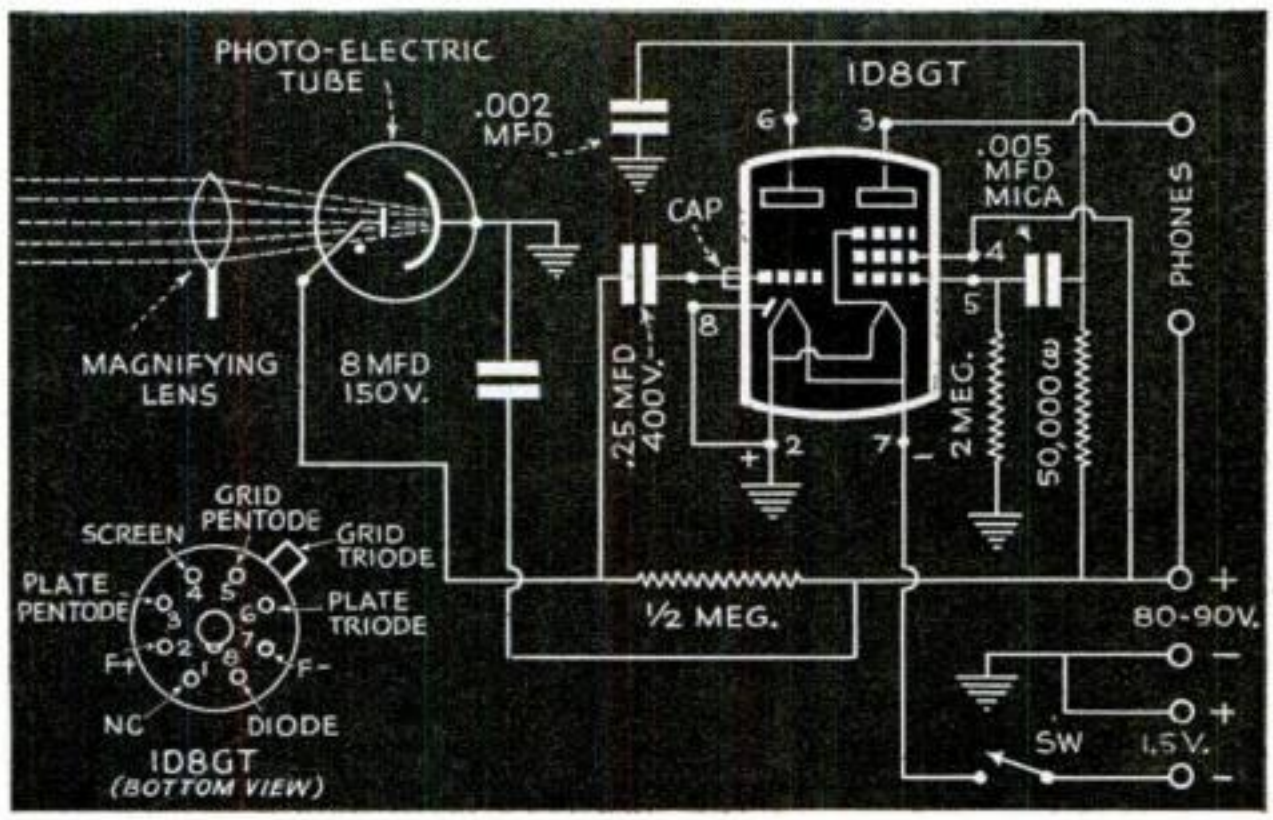


out on the telegraph key are superimposed on this light beam. Light variations forming the message are invisible, and to all appearances the rays from the flash light form a steady beam.

With this device, messages can be sent through windows, foliage, or anything that allows at least part of the light beam to reach the receiver.

A gas-filled photo-electric tube is used as a detector in the receiver, and this is followed by a two-stage, resistance-coupled audio amplifier. The photo cell transforms the modulated light beam into sound which is amplified by the audio stages.

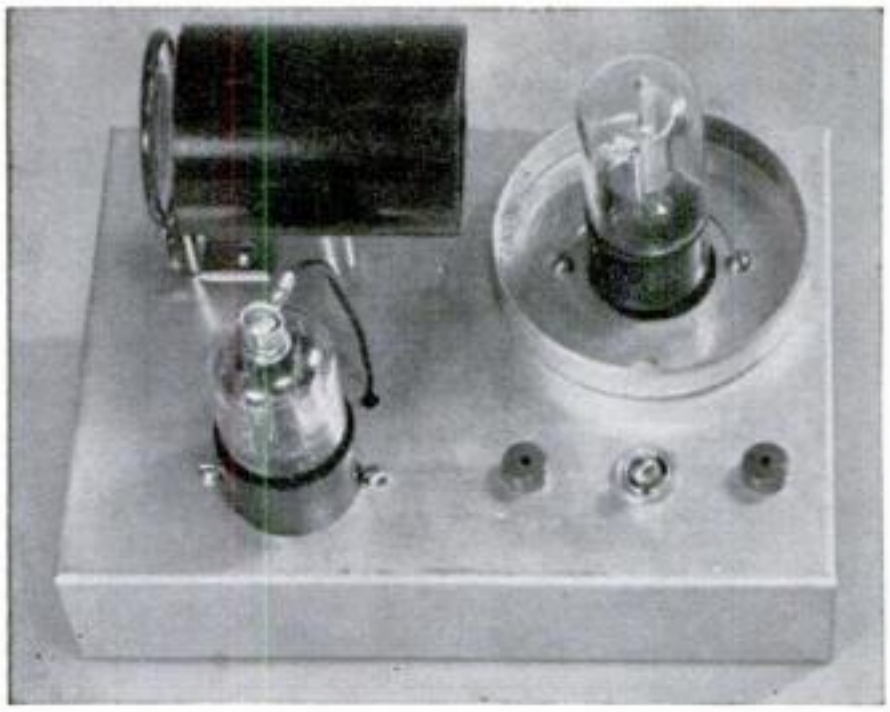
As a matter of fact, any good audio amplifier can be used after the detector stage. Care must be taken, however, to see that the photo tube never has more than 90 volts on its plate, to avoid damaging the tube.



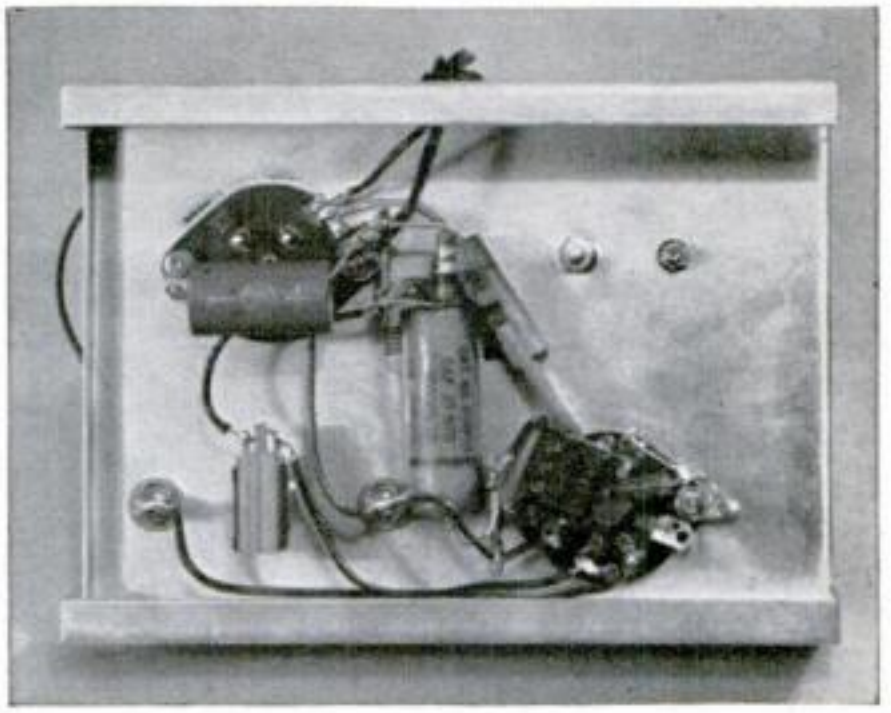

Schematic diagram of the receiver, with a bottom view of the 1D8GT tube

To focus the rays of light from the transmitter, a magnifying glass is placed 4" from the curved cathode inside the photo tube. To enable the receiver to work in a lighted room or outdoors (if the sun is not too bright) a black composition tube, 1¾" in diameter and 2½" long, is placed between the can and the magnifying lens.

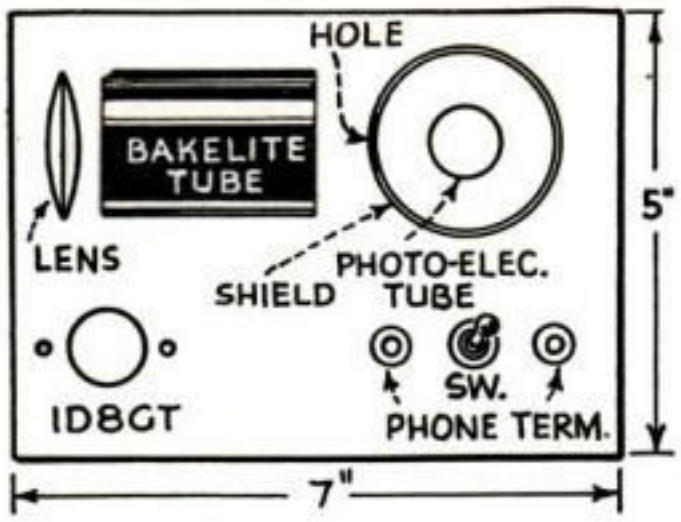
For the amplification a 1D8GT tube with



The top of the receiver with the shielding taken off



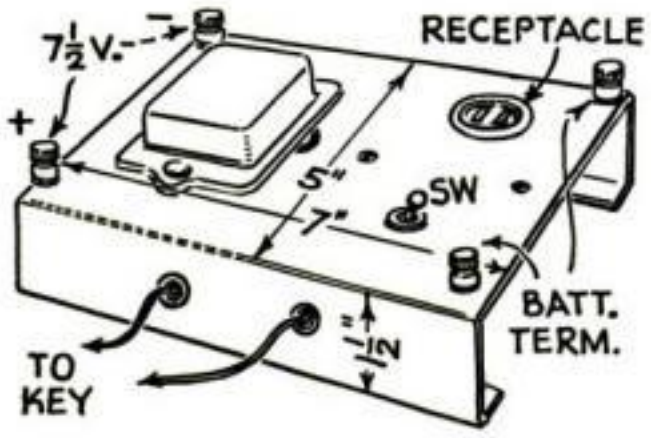
A bottom view, showing the condensers and resistors

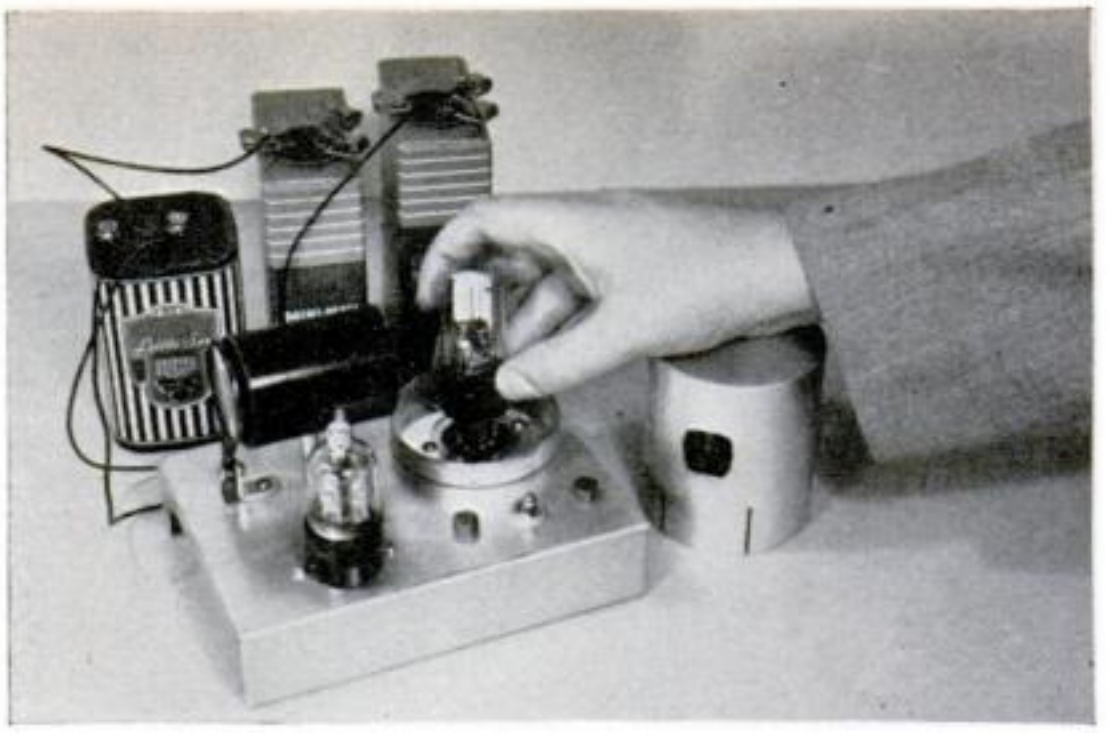



a 1.4-volt filament is used. To operate the receiver, two 45-volt "B" batteries and a 1½-volt "A" battery are needed.

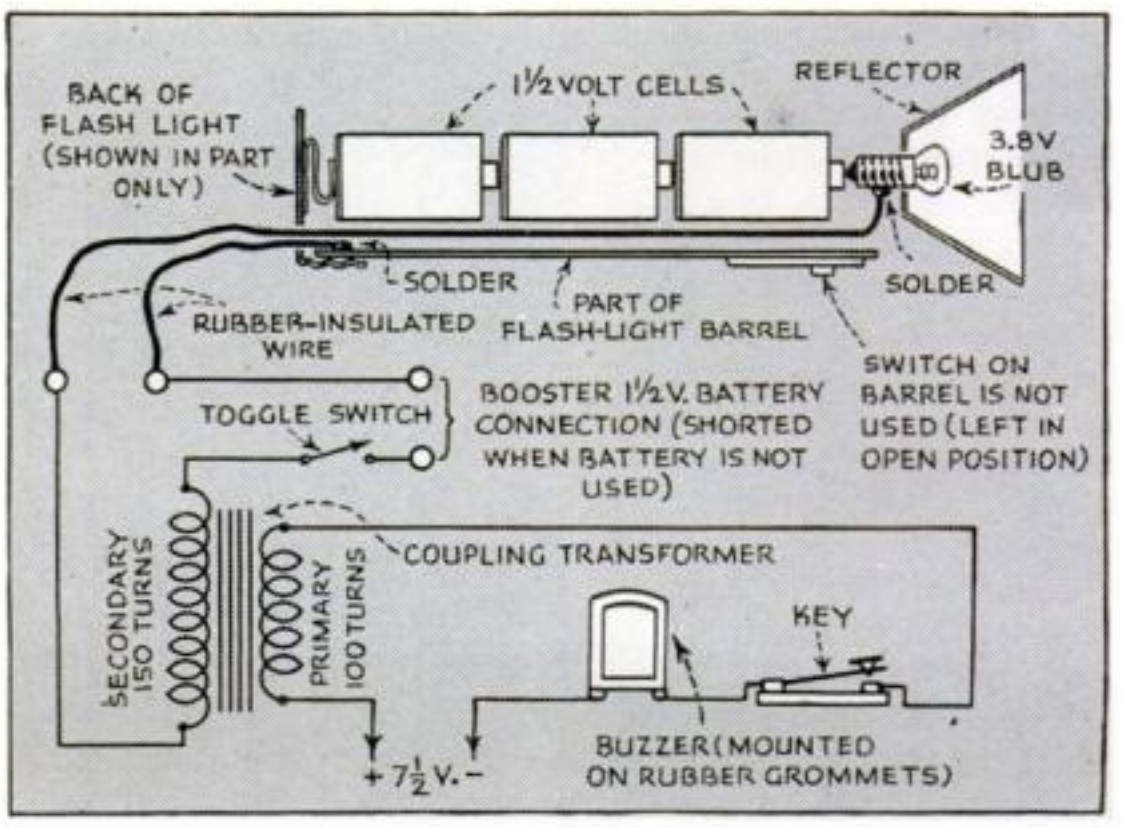
If the photo-electric cell fails to operate during reception of a signal, discharge the .25-mfd. condenser by shorting it.

To make the coupling transformer used in the transmitter, use an iron core made from an old chisel or a hollow iron shaft about ½" in diameter. Around this wind 100 turns of No. 24 d.c.c. wire and then another 150 turns of the same wire to form the primary and secondary windings.



Putting the photo-electric tube in place. Note the hole in the shield. At the left is the detail of the receiver chassis




The transmitter circuit. The chassis detail is at the left

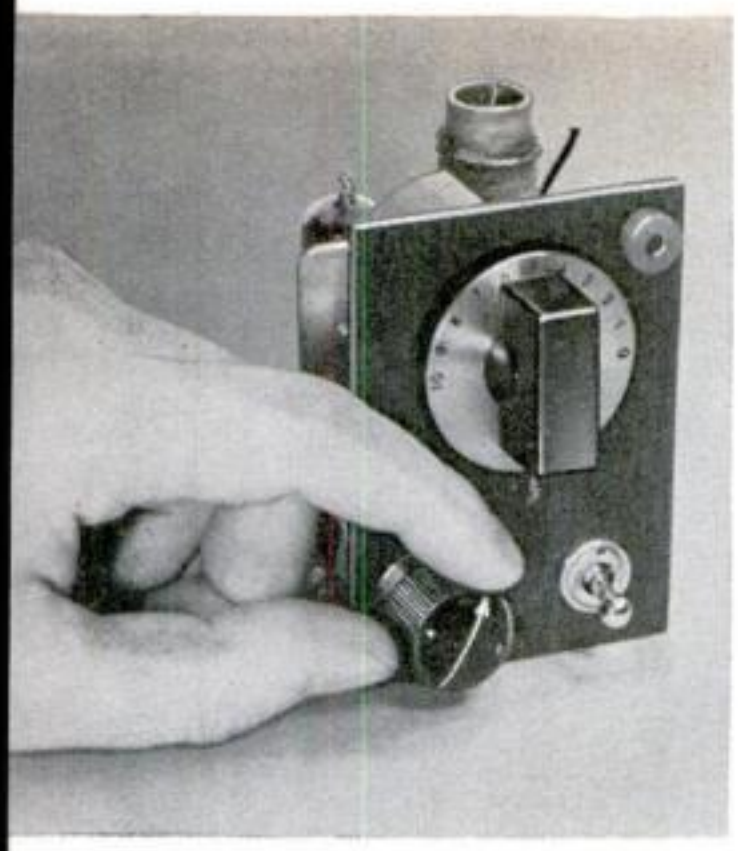
## LIST OF PARTS FOR THE LIGHT-BEAM SET

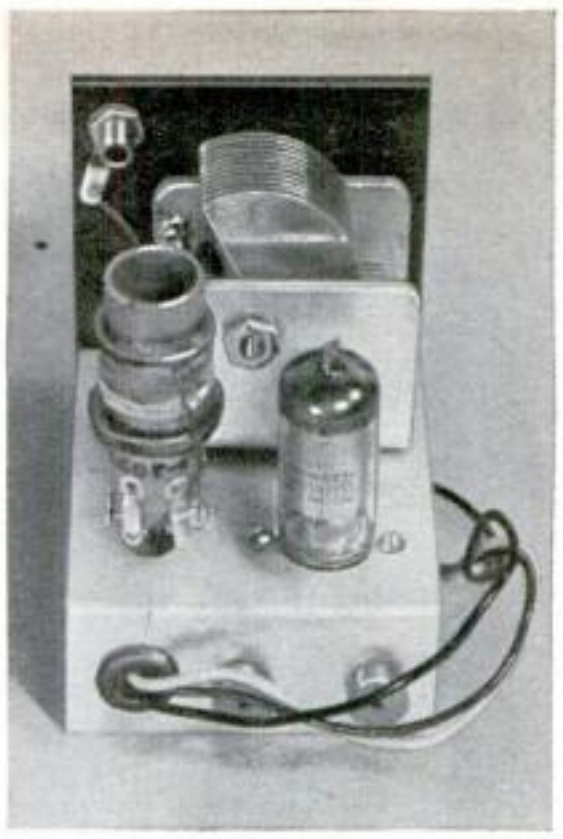
### Transmitter

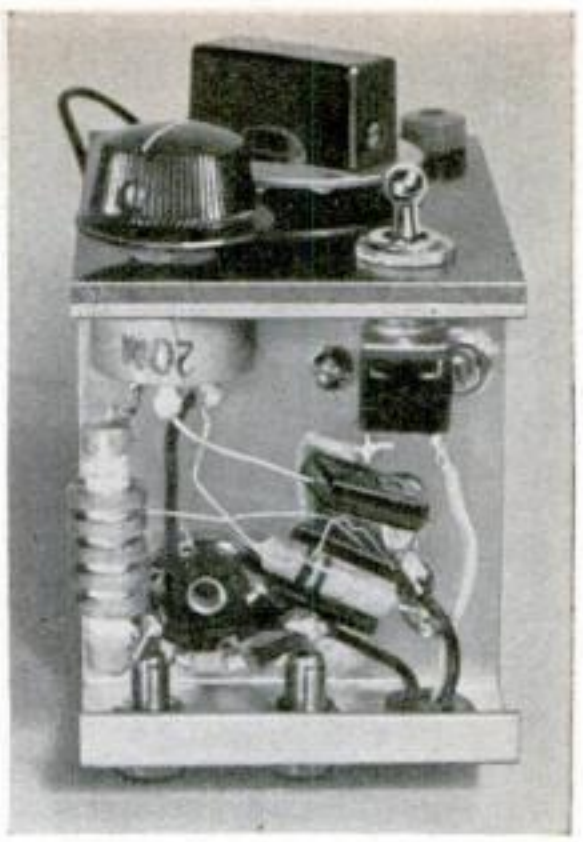
Three-cell flash light (with metal barrel)
Four-section tripod.
Metal chassis (7" x 5" x 1½").
Household buzzer.
7½-volt "C" battery.
Telegraph key.
Special coupling transformer.
S. P. S. T. toggle switch.
Four insulated binding posts.
Spool of No. 24 d. c. c. wire.

### Receiver

Photo-electric cell, type 923.
Dual amplifier tube, type 1D8GT.
Four-prong socket, wafer type.
Eight-prong socket, wafer type.
Metal chassis (7" x 5" x 1½").
Coil shield.
Electrolytic condenser, 8 mfd., 150 v.
Paper tubular condenser, .25 mfd., 400 v.
Paper tubular condenser, .002 mfd., 400 v.
Mica condenser, .005 mfd.
S. P. S. T. toggle switch.
Insulated 'phone terminals.
Carbon resistor, 500,000 ohms, ½ watt.
Carbon resistor, 50,000 ohms, ½ watt.
Carbon resistor, 2 megohms, ½ watt.
Two portable "B", batteries, 45 v.
Midget "little six" "A" battery, 1½ v.
Black tubing 2½" long.
Pair of head 'phones, 2,000 or 4,000 ohms.
Approximate cost of receiver parts is $5.84.
Transmitter, 3.10.
Batteries for both sets, 1.86.
Prices include tubes.







Front, rear, and bottom views of a compact one-tube receiver that you can take along almost anywhere. Power to operate the tiny set is supplied by a 1.5-volt flash-light cell and a midget 45-volt battery

# MIDGET RADIO HAS 400-MILE RANGE

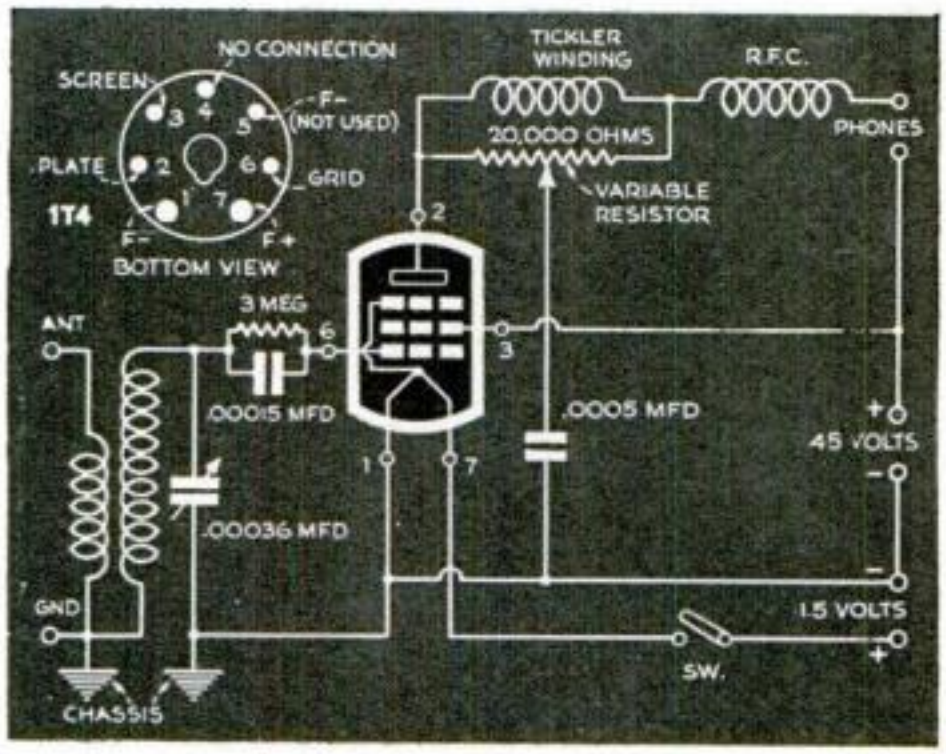
SMALL enough to be carried in a knapsack on hiking trips, this midget one-tube broadcast set will receive radio signals over distances up to 400 miles at night. It uses one of the new small-size RF pentode tubes as a regenerative detector, and all parts are standard.

To conserve space, an unshielded antenna coil is used instead of plug-in coils. Twenty-five turns of No. 34 d.s.c. wire are wound around the lower portion of the grid winding of the coil. This serves as the tickler.

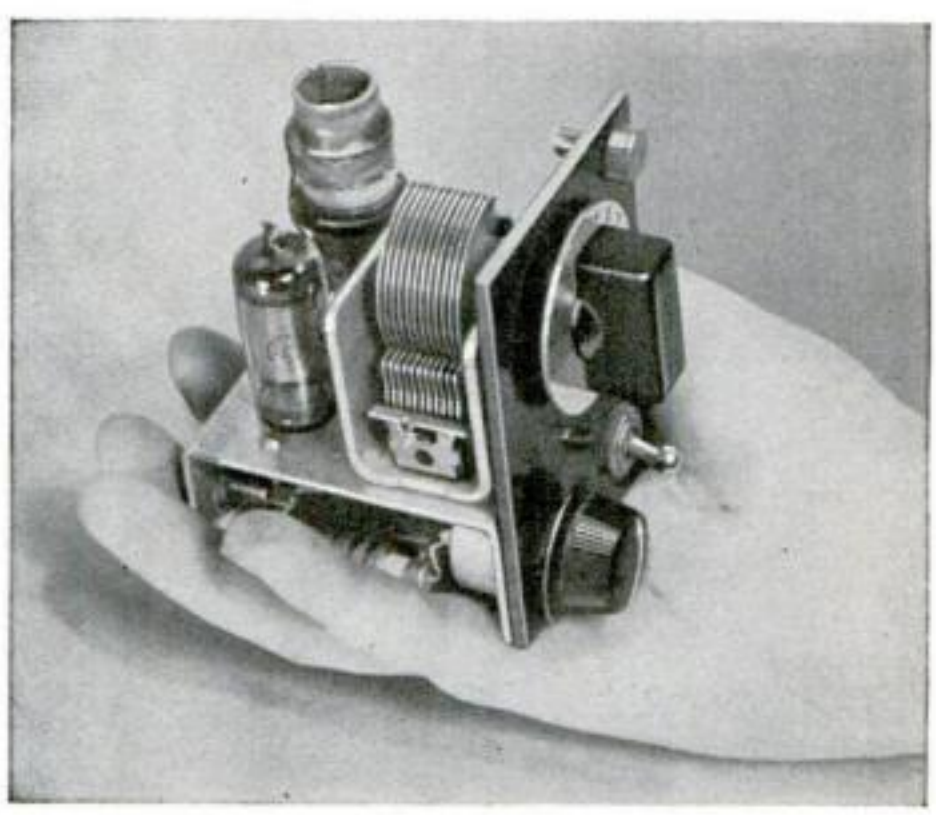
A midget seven-prong wafer socket for the tube is mounted on the 2¾" by 2½" by 1⅛" chassis in the conventional manner. A S.P.S.T. switch placed in the "A"-plus lead turns the set off and on and is mounted on the panel beside the variable resistor.

The antenna plug is mounted at the upper right-hand corner of the panel. The ground plug is mounted on the chassis beside the tuning condenser, while the insulated phone-tip jacks are mounted at the back of the chassis.

A 1.5-volt flash-light cell and a midget 45-volt battery supply power for the set. Outdoors, a long nail driven into the earth can be used as the ground, while a 40-foot wire strung to the branch of a tree serves as an antenna.




A small-size RF pentode tube, mounted in a seven-prong wafer socket, serves as a regenerative detector



This gives an idea of the size of the set. To save space, an unshielded antenna coil replaces plug-ins

A dolly shot of a dancing couple. The hoop keeps the pair in focus, and is high enough not to trip them. Below, the camera, on its wagon, stays its distance as the dancers move, and the cameraman just shoots

The writer of this article, a professional cameraman for 22 years, has filmed such successes as "Ruggles of Red Gap," "Old Ironsides," "Dancing Co-Ed," and some of the Dr. Kildare pictures. He experiments constantly at home with an 8-mm. camera and other amateur equipment. As contributing editor of "American Cinematographer," he keeps abreast of the newest techniques used by Hollywood cameramen. Here he reveals a variety of tricks for maintaining good focus when taking home movies.

# Better Focus in Movie Making

By A. L. GILKS, A.S.C.

HASTE and carelessness in focusing probably spoil more film footage than any other single error in taking home movies. Nor is this mistake restricted to amateurs. Not long ago a professional cinematographer crossed the continent to shoot a single scene, only to find when he returned and developed the film that it was out of focus. No laboratory magic will correct this fault, whether it occurs on a film exposed in a home movie camera or a $15,000 professional outfit. However, the same methods may be employed in both instances to insure sharp images.

Professional directors of photography use cameras fitted with costly focusing mechanisms. These permit viewing the scene on a ground-glass focusing screen through a magnifying eyepiece, and thus determining when the camera is properly focused. Having done this, the professional then does exactly what you can do in the first place. He "runs a tape."

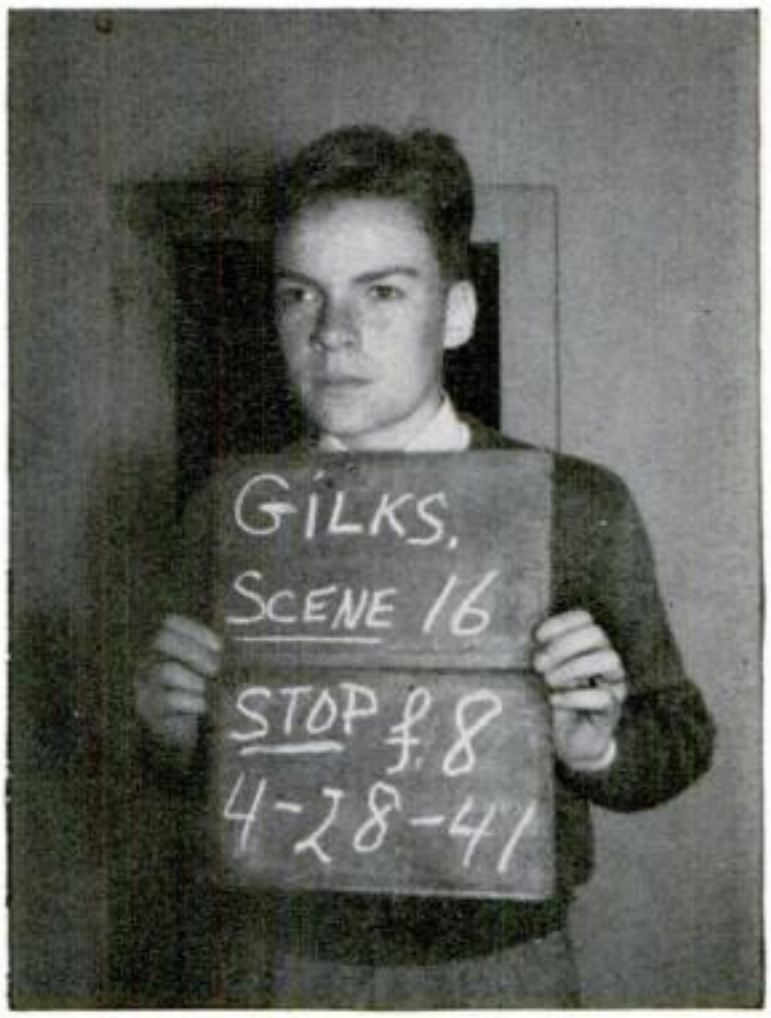
By runing a tape is meant measuring to the inch the distance from the lens to the subject. A small hook can be fastened to the side of the camera, and the free end of the tape attached to it. The tape reel may be kept in a small bag hung from the tripod. When this method of attachment is used, it will be unnecessary to unhook the end of the tape, and distance readings may be taken automatically from the camera itself.

In the same bag may be kept a flash light, chalk, masking tape or binding tape, and adhesive tape.

Have you ever tried to keep in focus a couple walking toward the camera, while it is being drawn ahead of them? In making long shots, this offers little difficulty. However, in shooting close-ups indoors with the lens wide open, the problem becomes a really complicated one. Try as you may, you cannot keep your subjects exactly five feet from the lens. They step ahead at times and fall back at others, so that the image produced on the film is now sharp, now blurred.

The simple solution for this problem, and one which we use constantly in Hollywood, is to make what we call a "dolly shot." Your dolly may be nothing more than a child's coaster wagon. Most of these toys nowadays are made entirely of metal, so with one of these it will be necessary to drill four holes through the bottom of the body. One should be 3" from the front edge of the wagon, another directly under

Measuring the distance from the lens to the subject's face guarantees accurate focus. With the end of the tape attached to the camera itself, the reel can be pulled out readily with almost automatic results—no fuss and no bother




Slate provides a record of scene number, camera stop, and date. This is the standard practice followed by professional cameramen in making pictures on Hollywood lots

X marks the spot where the subjects stop for dialogue or business. Chalk is used on the sidewalk or a floor where it can be rubbed off, and easily removable Scotch tape does the trick on carpets

the head of the tripod, and the other two over the rear axle assembly.

Nail an ordinary lath to the outer end of a 1″ by 1″ pole 5′ long. Either bolt the pole to the underside of the wagon bed, extending it straight to the rear; or fasten it to an eyebolt or stove bolt through the forward hole, allowing it to rest on the back edge, which will bring it up at a slant behind the wagon. The former method will permit medium shots without showing the feet; the latter raises the lath high enough to prevent stumbling and is suitable for making extreme closeups. Simply have your subject walk against the lath while you shoot from the dolly and somebody else pulls the wagon.

To photograph dancers, substitute a hoop for the lath, slipping it over them. The hoop should be just large enough to allow them to dance freely; one 3′ in diameter is usually adequate. Effective shots may be obtained by using a single flood light, either held above or clamped to the camera. Have an assistant pull the wagon, moving it around the room, while you handle the camera. By all means tie the tripod to the wagon by fastening a fine wire from the tripod head to the bolt directly underneath it. An upset might be disastrous.

It is often necessary to change focus during the progress of a scene as subjects cross the camera's field diagonally, or approach or recede from the lens. With practice, you will learn to adjust the focusing dial as the action progresses. But the problem arises how to tell when your subjects have stopped at the exact distance previously decided upon.

Here chalk and tape should be used. For close-ups, in which the subject's feet will not be seen, mark the spots with chalk, using V's or X's or straight lines. For long shots, particularly when working on carpets, polished floors, and hard-surfaced walks against which chalk marks would stand out objectionably, use Scotch tape. Mark each person's position carefully, and during rehearsal note the exact focus that will be required in each case. Two or more sets of marks may be placed at different points wherever critical focus is important.

Remember that the depth of focus—that is, the range of distances within which film images will be sharp for any given focus setting—increases as the lens is stopped down, and also increases with the distance between subject and camera.

Fortunately, the lenses with which most 16-mm. and 8-mm. cameras are equipped provide great depth of field—far more than those of 35-mm. professional cameras. (The majority of 16-mm. cameras have 25-mm. lenses; most 8-mm. outfits have 12½-mm. lenses.) Even when wide open, such short-focus lenses afford tremendous depth of focus. Occasionally, however, you will encounter a situation best met with a trick we employ every day on professional sets. This is "split focus."

Suppose you are filming two persons in one scene, one of them 6′ and the other 12′ from the camera, which is a 16-mm. machine. Light conditions demand a diaphragm opening of f/2.8. If you focus on the nearer subject, the farther one will be out of focus, and vice versa. The solution is to split the difference, focusing arbitrarily at 8′. On the other hand, if your nearest character is 7′ from an 8-mm. camera, and you have stopped down to f/3.5 or a smaller opening, all parts of the scene from 7′ to infinity will be in sharp focus.

A depth-of-focus table will quickly inform you of the correct setting for your lens at various stops and subject-to-camera distances. By all means obtain such a table and take it with you whenever you intend to shoot pictures.

The folowing examples illustrate how stopping down increases the depth of focus. Let it be supposed that you are working

with a 16-mm. camera and a 1″ lens. Indoors your meter reading requires a lens opening of f/2. If you set the focus scale at 5′, the picture will be sharp from 4′ 6″ to 5′ 7″ from the lens. Going outdoors, you find it necessary to stop down to f/8. But at this stop, with the focus scale still at 5′, the picture will be sharp from 3′ 3″ to 10′ from the lens.

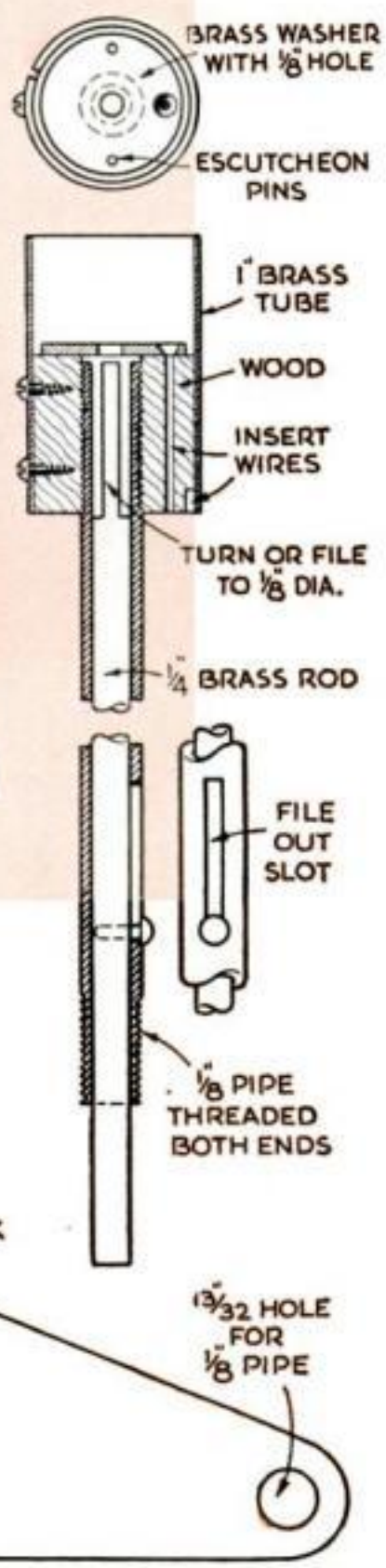
Some scenes require a change of stop as well as of focus during the action, as when a subject moves from sunlight into shadow. A little practice will enable you to open or close the diaphragm to the proper stop while shooting.

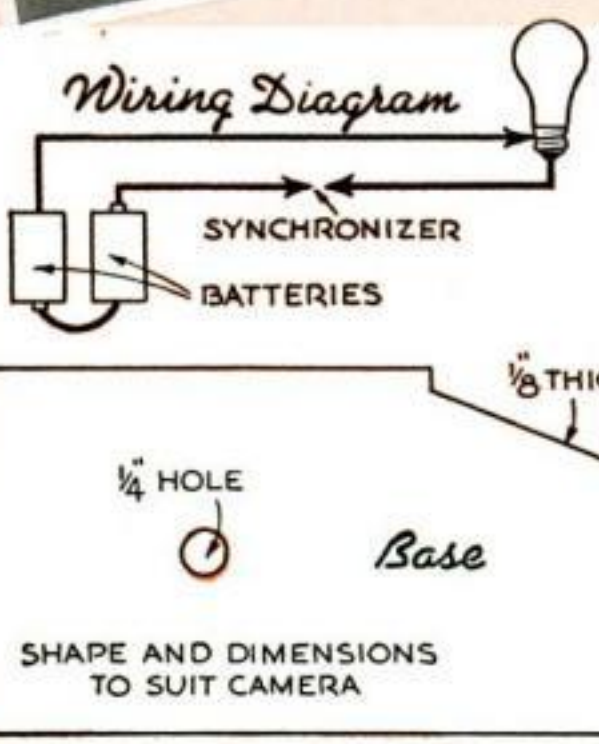
To follow the focus accurately is somewhat more difficult. Fortunately, the average scene calls for only one or two changes of focus, as for example from a full-length shot to a close-up. First, run a tape to your subject at both points. Having determined the distances, grasp the lens with your free hand and move it from one focal position to the other, according to the calibration marks. By noting the position of your hand and practicing a few times, you will eventually be able to make the change more or less automatically. It is a trick well worth mastering.

As an improvement on this method, you can fit a short metal rod to the focusing ring by means of a simple clamp, setting the rod so that it will, for example, bisect the finder when in the second required focus position. Start shooting at the first focus, and change to the second position as necessary. When the rod is aligned with the finder, you can be certain that the lens is properly focused for shooting the second part of this particular scene.

Another dolly shot, this time with a lath nailed across the end of a 1" by 1" pole attached to the wagon. Walking subjects push against the lath . . . wagon and camera move . . . presto, they're always in focus

# Flash Gun BUILT WITH BULB EJECTOR




## By CHARLES BROWNOLD

HERE is an easily made flash gun designed for use on a camera having a built-in synchronizer or in conjunction with a commercial synchronizer. Its features are balanced weight, compactness when taken apart, an adjustable reflector socket, and an ejector for hot bulbs. Modification of the base plate adapts the gun to almost any camera body.

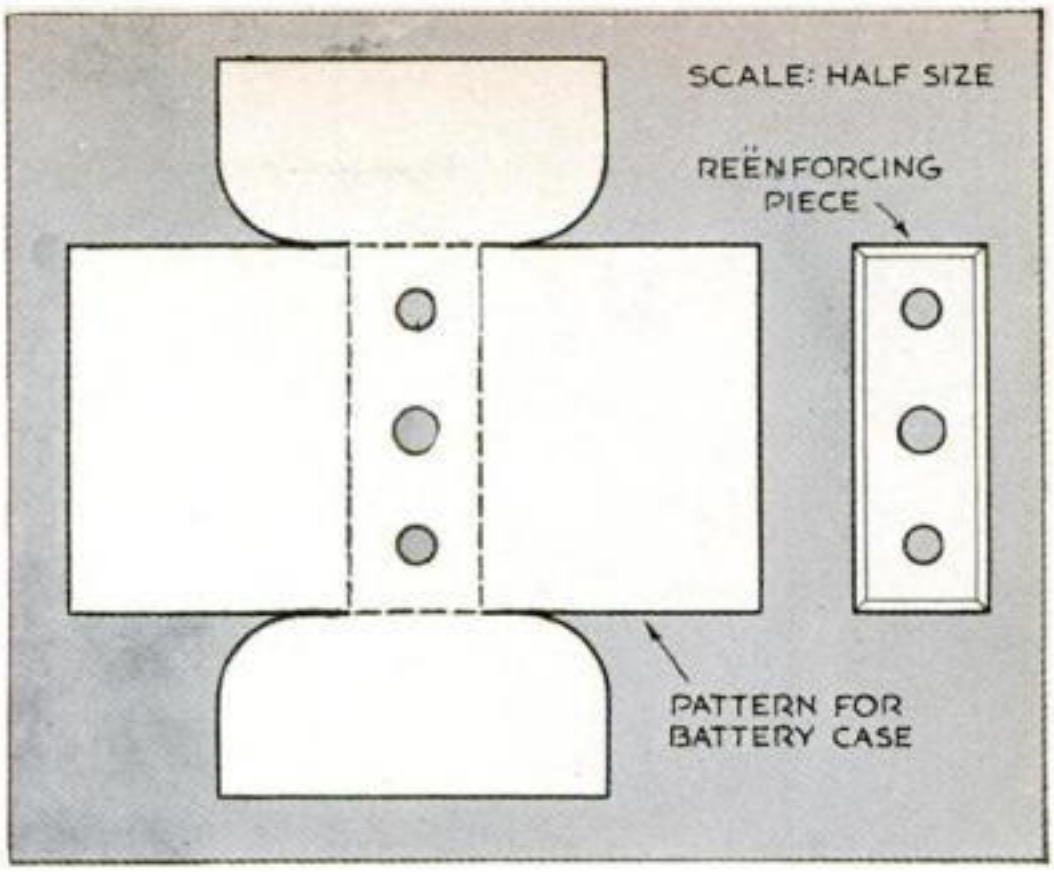
To reduce strain on the tripod socket, the bulb socket and reflector are attached to the upper end of a length of 1/8" pipe, which is about 3/8" outside diameter, and the battery case fastens beneath the camera. The reflector bracket slides on the pipe and may thus be centered for bulbs of various sizes.

The core of the bulb socket is a hardwood cylinder about 3/4" long and exactly 1" in diameter, having a hole 3/8" in diameter drilled through its center. Around this cylinder is fitted a split metal collar made by sawing a 1 3/4" length of 1" brass tube down one side, and this

is attached by two small wood screws, both on the same side of the gap. Acting as a spring clamp, the collar holds bulbs firmly, yet permits them to be pressed into place and ejected easily.

A brass washer, small enough not to touch the collar, is fastened to the top of the cylinder by means of two small escutcheon pins. The completed bulb socket is screwed down over the threaded tube, cutting its own threads.

The bulb-ejector plunger is a metal rod which slides in the threaded tube and up through the brass washer. It is 1" longer than the tube, and 1" of its upper end is reduced to a diameter slightly smaller than the hole in the washer. The plunger is prevented from falling out, after it has ejected a bulb, by a pin which rides in a slot in the tube.




The battery case is cut as shown from light sheet brass and soldered. A strip of heavier metal reënforces the bottom

Hexagonal nuts lock the tube to the base, which is cut from ⅛" metal to suit the shape of the camera. A ¼"-20 wing bolt through battery case and base threads into the camera tripod socket. Solder wires to thin brass pieces and fit these into the battery case, insulating them with cardboard. Another brass strip connects the cells, cap to base, as in the diagram.

Electrical connections are simple. One wire that leads from the battery is soldered to the lower edge of the bulb collar; the second wire from the battery terminates in the lower synchronizer jack, while a wire led up through the bulb cylinder, and soldered to the washer, ends in the upper synchronizer jack.

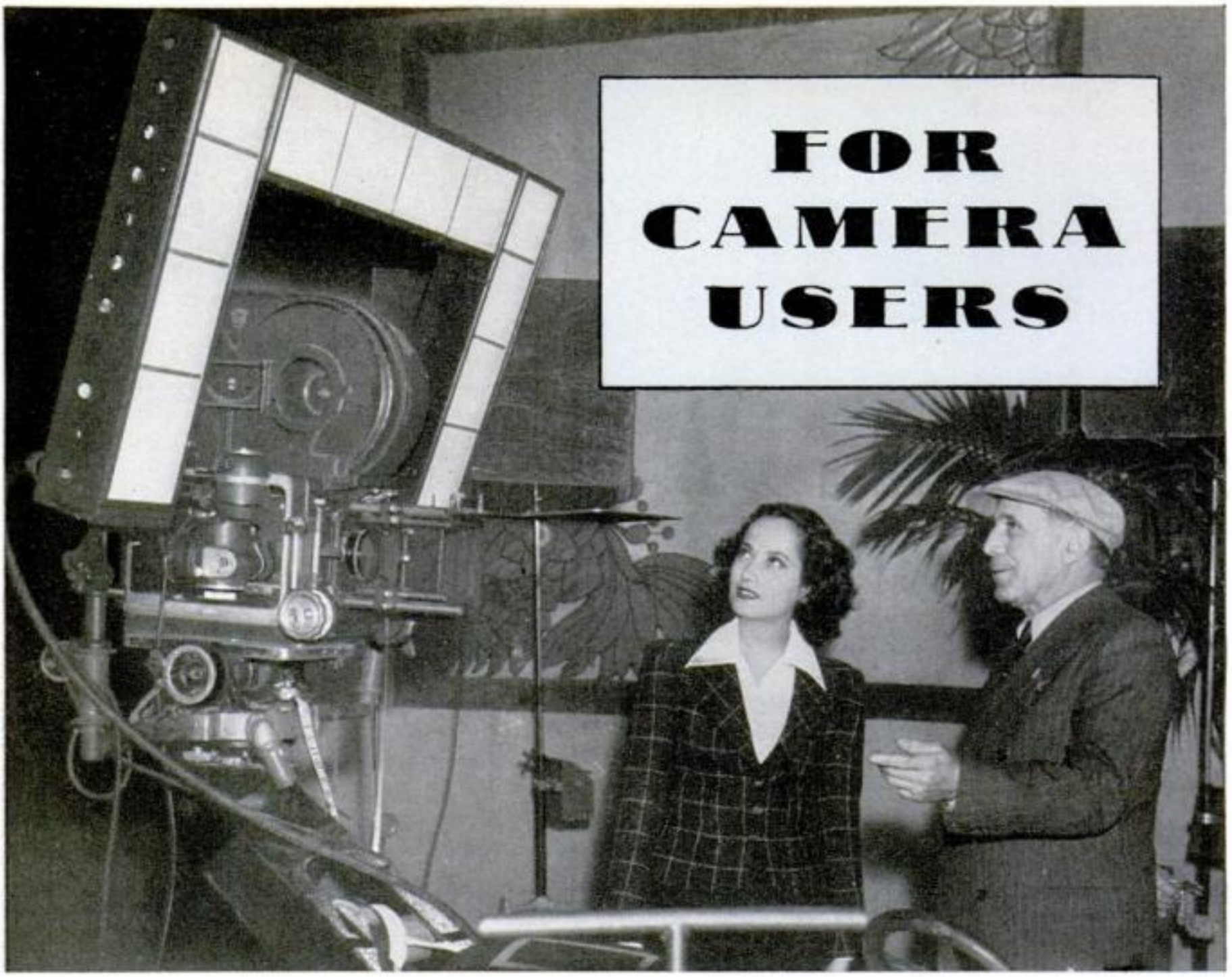
The gun is finished with a coat of thin, hard-drying black paint. Glue felt to the base plate to protect the camera. A wrench for assembling and dismantling the gun may be filed from flat metal, as shown.

## Support Steadies Binoculars for Taking Telephoto Shot

MOST amateurs know that telephoto shots can be taken through a small telescope or one leg of a pair of binoculars. The difficulty lies in mounting such a cumbersome makeshift on the camera.

A simple way is to place under the camera a thin board, with a hole for the tripod screw, and bind the telescope on with strong rubber bands. Layers of cardboard block the auxiliary lens up level with the camera lens.

A plate-back camera or a single-lens reflex is convenient for constantly checking focus, but even the cheapest box may be used. A nonreflex roll-film camera may be focused by placing waxed paper or ground glass over the film opening before the roll of film is inserted in the camera.—ROBERT SCOTT.

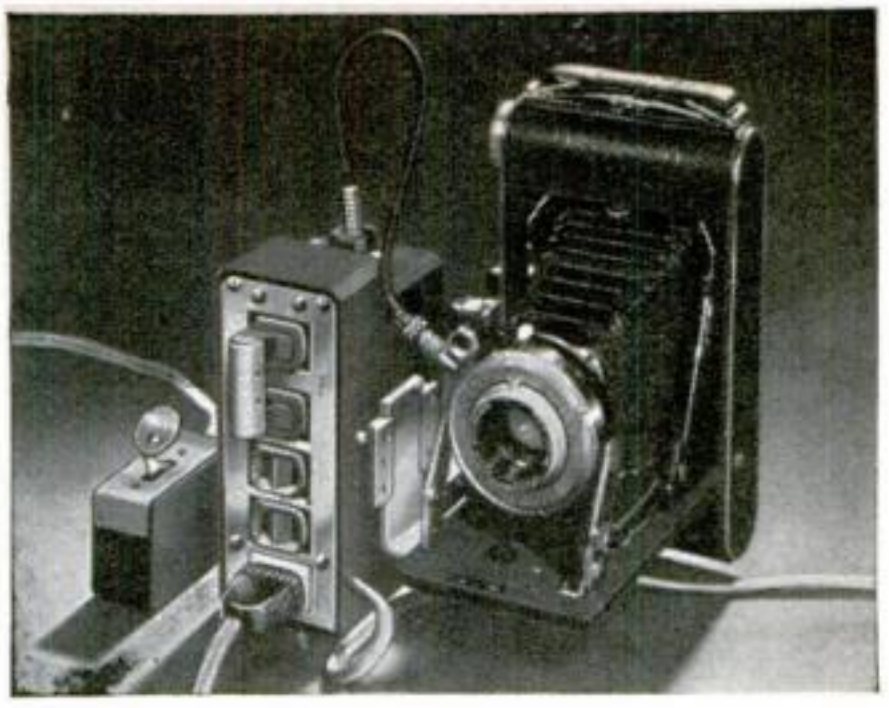



**HORSESHOE LAMP.** To control modeling, key lighting, and balance from a single source, Tony Gaudio, a Hollywood, Calif., cameraman, has fitted his camera with an inverted horseshoe-type arrangement of lights. This is mounted above the lens, and the top and sides house twelve lighting units, each containing one 100-watt lamp. Any or all may be turned on by separate switches. Brilliance is controlled by a dimmer as the camera trucks backward and forward. A single cable powers the unit. Chief advantage of the arrangement is that the lighting angle with relation to the camera always remains constant.

**POCKET PICTURE ALBUMS** of the new type illustrated need no paste, water, or mounting corners. Instead, the prints are fastened with a pressure-sealing adhesive, which works like a first-aid bandage strip. The protective covering is peeled off, and the print smoothed down on the strip with the fingers. By the use of clear plastic on the front of the album, any favorite picture may be mounted to serve as the front cover.

**A RADICALLY NEW GLASS,** with increased light-bending capacity, is being used in aerial lenses for government purposes. It is produced without the silicates heretofore required in making glass. Instead, the rare metals tantalum, tungsten, and lanthanum are used in its manufacture. The new optical material has a much higher refractive index than ordinary glass. A lens made of it therefore requires less curvature. Tests of aerial lenses so made reveal better definition and greater coverage, with no loss of lens speed. The use of rare-element compounds for glass making was suggested by Dr. G. W. Morey, of the United States Geophysical Laboratory. The new glass is the result of collaboration between him and the Kodak Research Laboratories, and its application is at present restricted to defense equipment. Widespread use will have to await the calculation of new lens formulas.

**DOUBLE 8-MM. MOVIE CAMERA.** Three speeds, a combined exposure meter and optical view finder, interchangeable lenses, focal-plane shutter, footage counter, and a powerful spring motor, features usually associated with high-priced cameras, are found in this new machine. It embodies three essentials necessary to successful color photography—a dependable exposure meter, accurate shutter speeds, and correct exposure over the entire picture area. All types of double 8-mm. color and black-and-white film may be used in it.



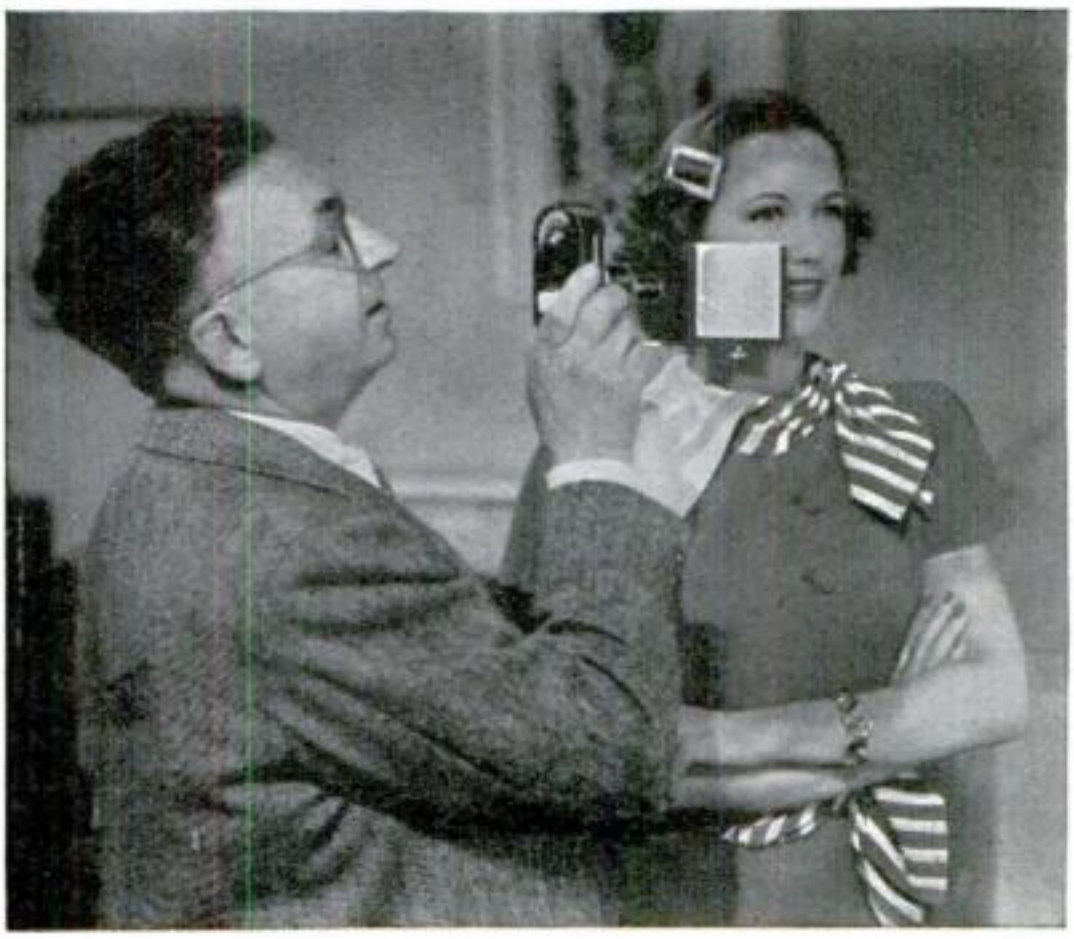
**PHOTOFLOOD SYNCHRONIZER.** Natural, unposed shots can be taken under photoflood lamps without glare or eyestrain and at considerably less than the usual cost with the aid of a new high-low switch control that is attached to the camera by a single screw. The flood lamps are plugged into the two black receptacles. Both camera and lights are then operated by a small remote-control switch, which the photographer holds in his hand. The photofloods burn like ordinary lamps during the focusing. Throwing the remote-control switch operates the camera's shutter and simultaneously burns the photofloods at full brilliance.

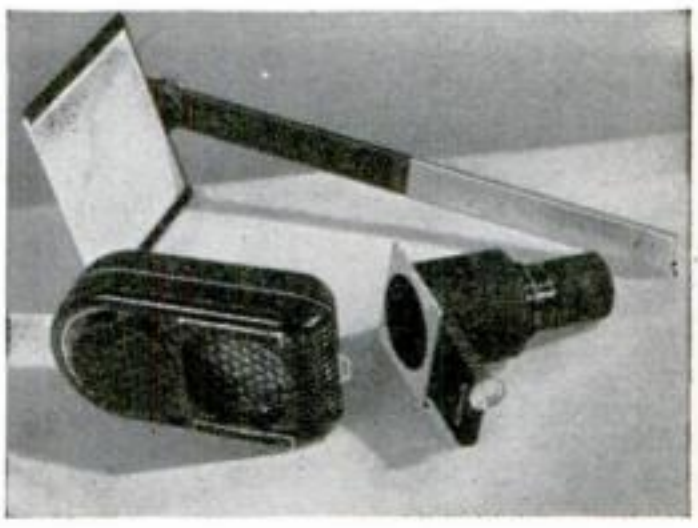
**A NEW TEMPERATURE STANDARD** of 68 deg. for development of both films and papers is announced by a large manufacturer. The change simplifies recommendations, and it is usually easier to maintain solutions at this temperature than at 65 deg.

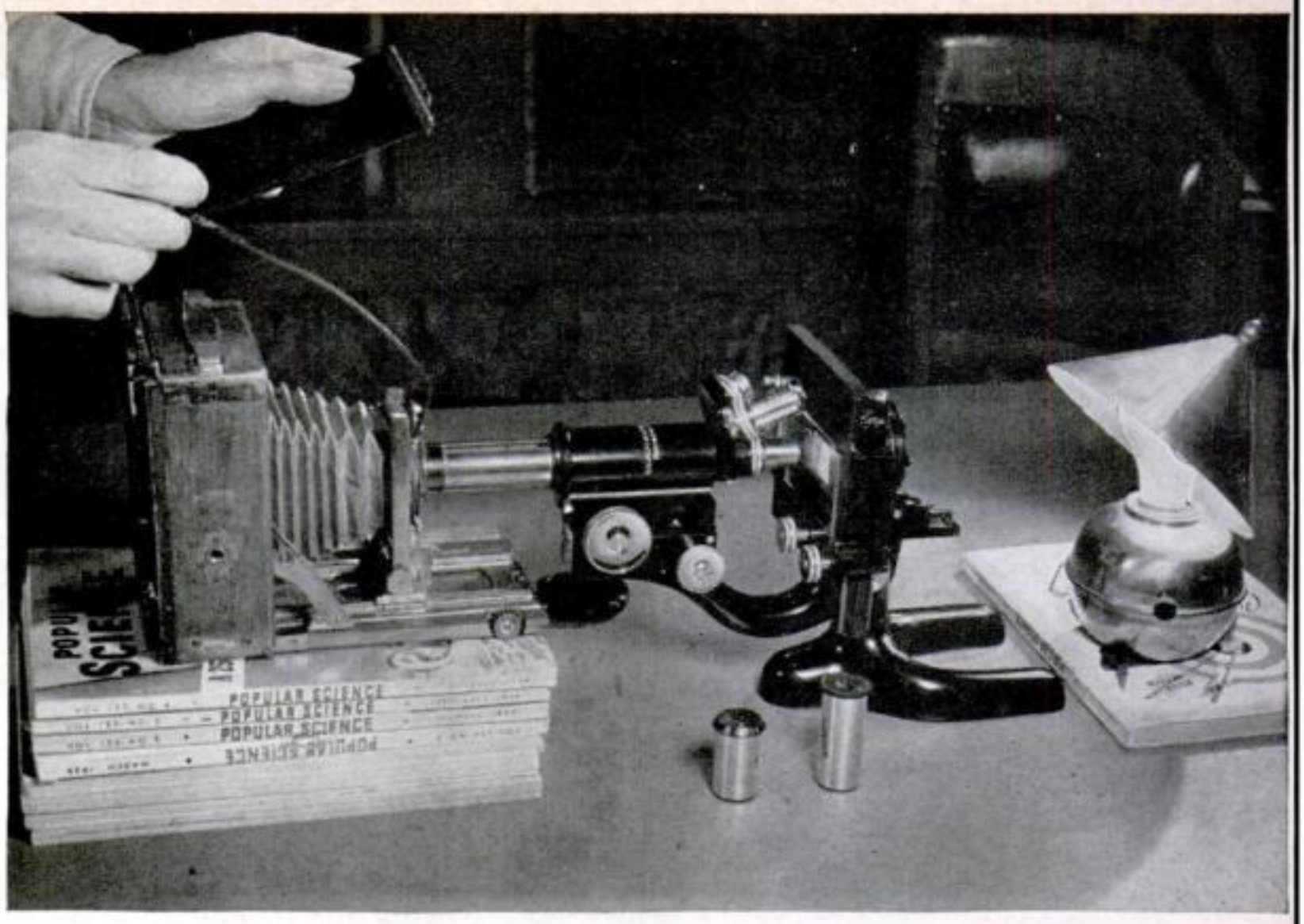
**DESIGNED TO MEASURE** light reaching a subject from a single source, rather than that from all sources, an ingenious adaptation of a standard exposure meter developed by Karl Freund, a professional cameraman of Hollywood, Calif., gives him instantly the brilliance of his key light, to which he then balances all his required auxiliary lighting.

The meter is fitted with clips permitting attachment of a 2″ camera lens before the cell. For low-intensity readings, the light baffle is swung out of the way. An 8″ metal bar extending from the front of the meter is provided with a target of white cardboard. This may be turned at an angle to avoid taking readings in the shadow of the meter. The photo below shows the parts.

Readings are made with the target placed against the subject's face, directly in the beam of the key light. For outdoor work the lens is removed and the meter used as usual.

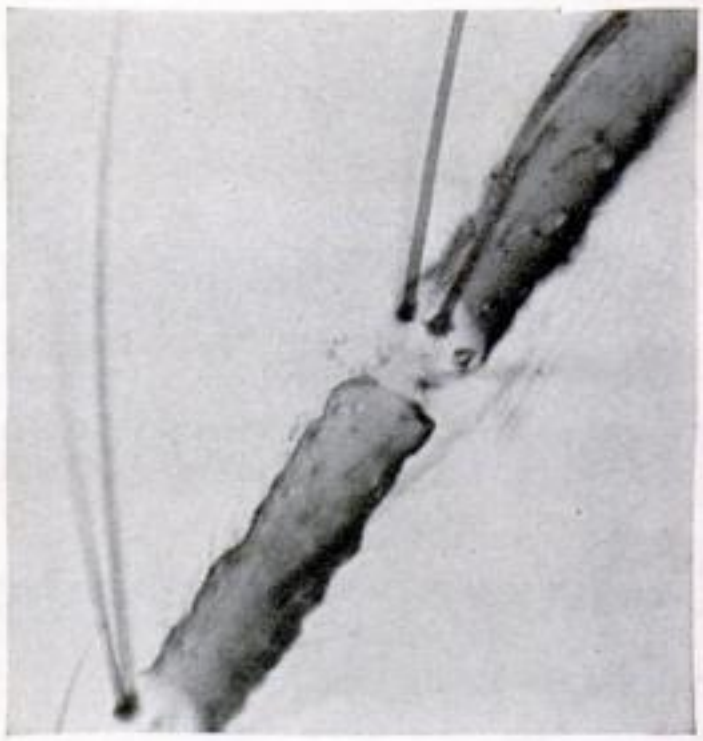


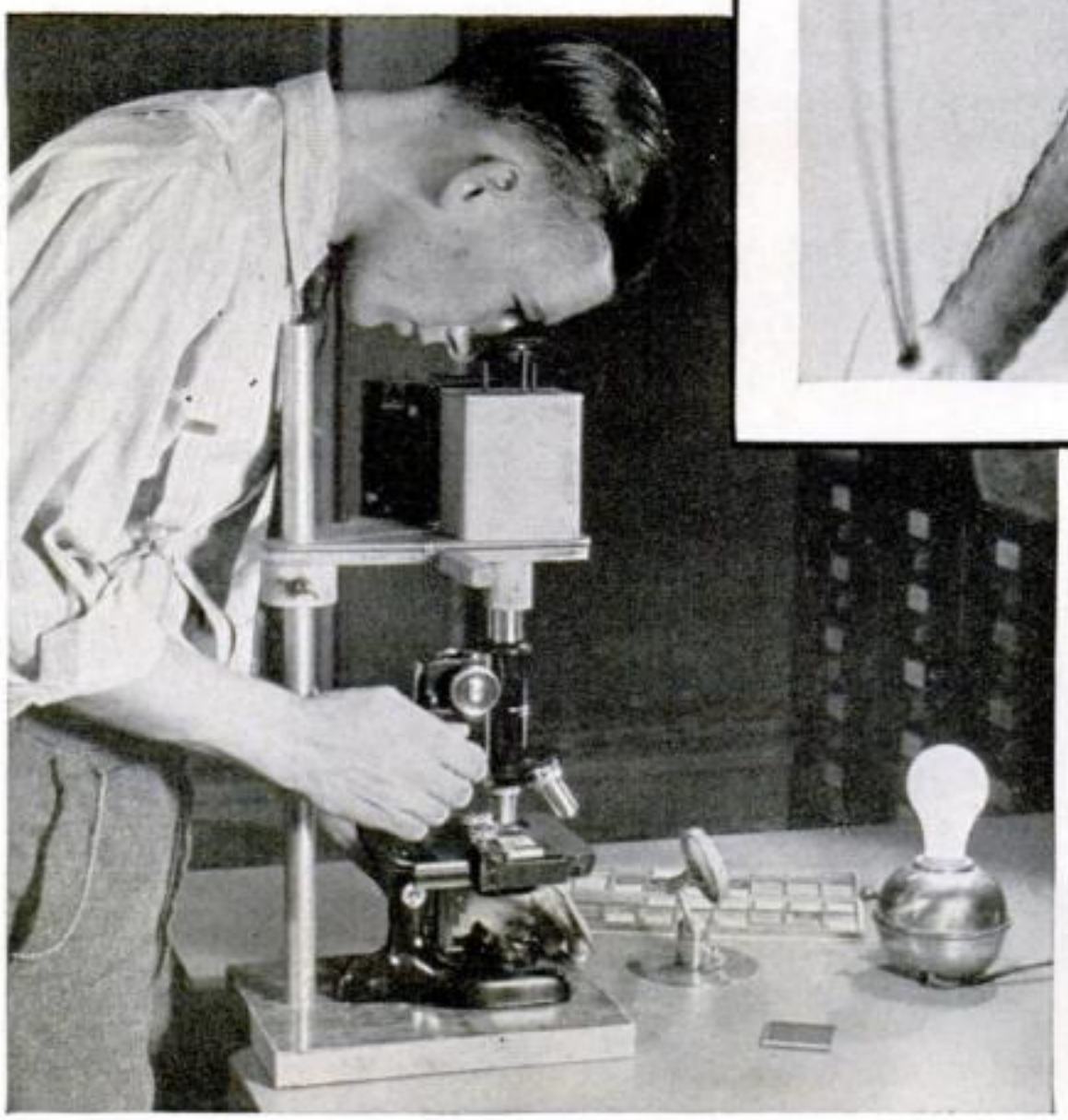





**Improvised photomicrography. The lens of this camera, focused at "infinity," is placed close to the microscope, which has previously been set by eye for a sharp image**

**The more convenient set-up below is homemade. The image is lighted by an ordinary lamp or photoflood and a condenser lens consisting of a reading glass on a ball-and-socket stand. The operator holds a color filter in his left hand. At right, the finished photo, part of a mosquito antenna**





# PHOTOS THROUGH YOUR MICROSCOPE

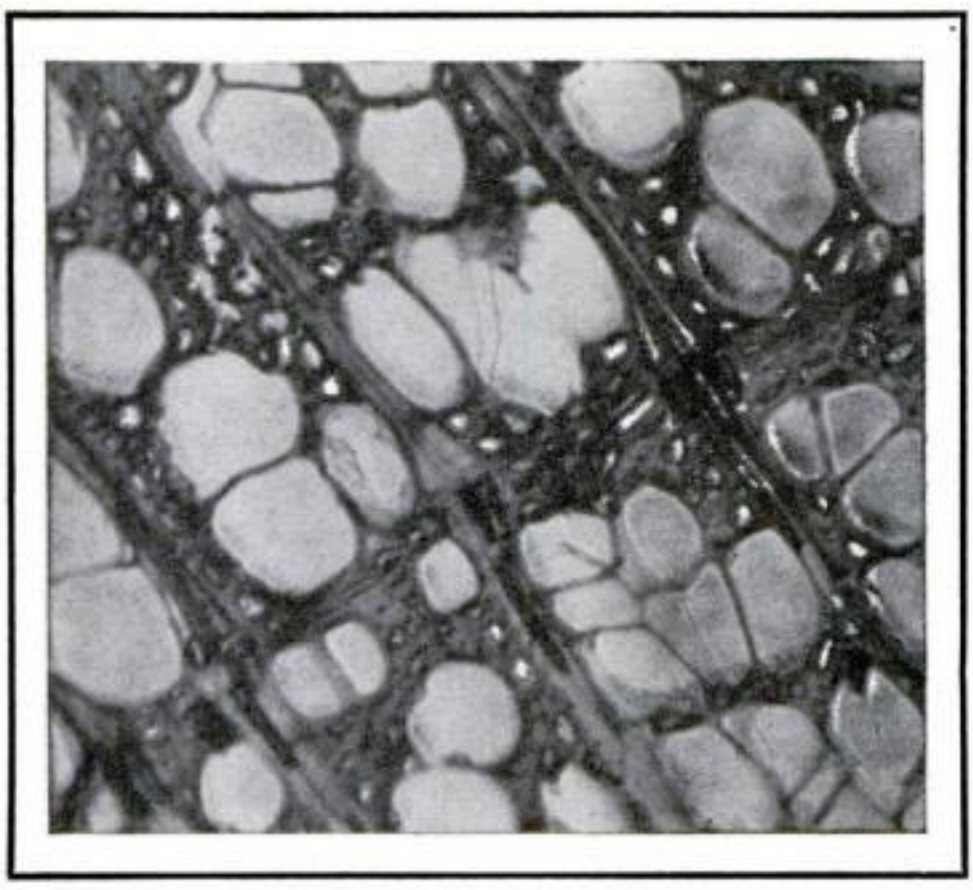
**By MORTON C. WALLING**

PHOTOGRAPHS made through microscopes have led to revolutionary discoveries in all branches of science and engineering, and have trapped many criminals. All you need to enter this important field of picture taking—or photomicrography, to use its technical name—is a microscope and a camera, preferably one which has no lens.

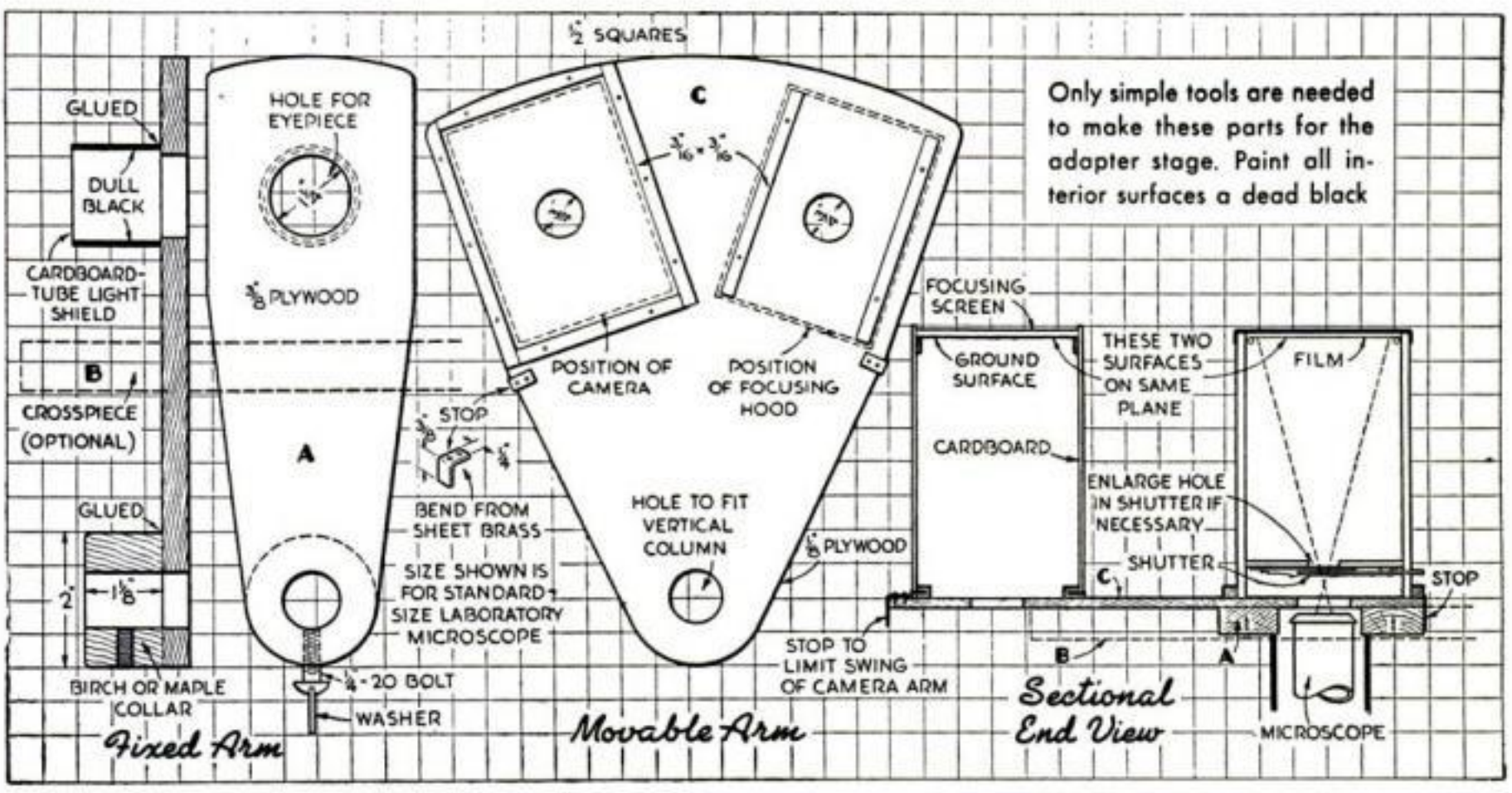
Should your camera have a lens you don't want to disturb, load with panchromatic film of moderate speed or a special sensitized material sold for photomicrography, and set the focus at infinity if it is a focusing model. Focus the microscope carefully on the subject. Support the camera so that its lens and the microscope eyepiece almost touch. Use brilliant illumination, such as a No. 1 photoflood or a 100-watt lamp for the exposure. When focusing the microscope, use dimmer light or a dense filter.

Regular photomicrographic cameras have no lenses. If your lens is removable, or you have an old "box," you can obtain even better results. A shutter is not at all necessary because most exposures are timed in seconds or minutes, and this can be done by turning the lamp on and off.

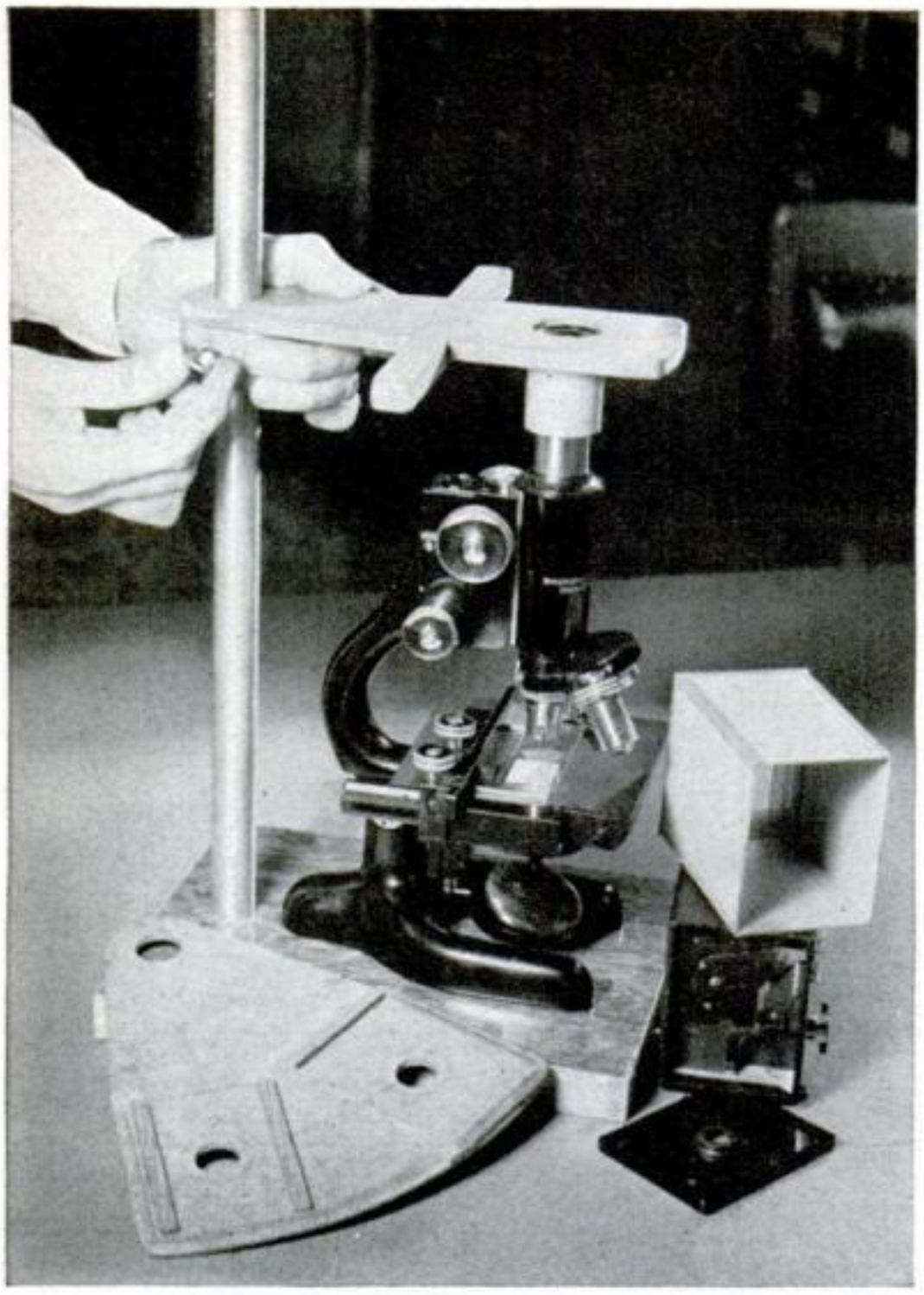
The upright of the photomicrographic outfit shown is a brass tube or rod ¾" in diameter, set in a base 5" by 10". To the rod is clamped a paddle-shaped arm *A*,



Cross section of poplar wood. This, like the photomicrograph on the facing page, was made with the outfit illustrated




Left, two views of fixed arm. Center, movable arm for camera and focusing hood. At right, cross section



Stationary arm being adjusted and clamped by set screw. Crosspiece to keep swinging arm from tipping is useful, but it can be omitted

glued to a hardwood collar and provided with a hole which receives the microscope eyepiece through a cardboard-tube light shield about 1¼" in inside diameter and 1½" long.

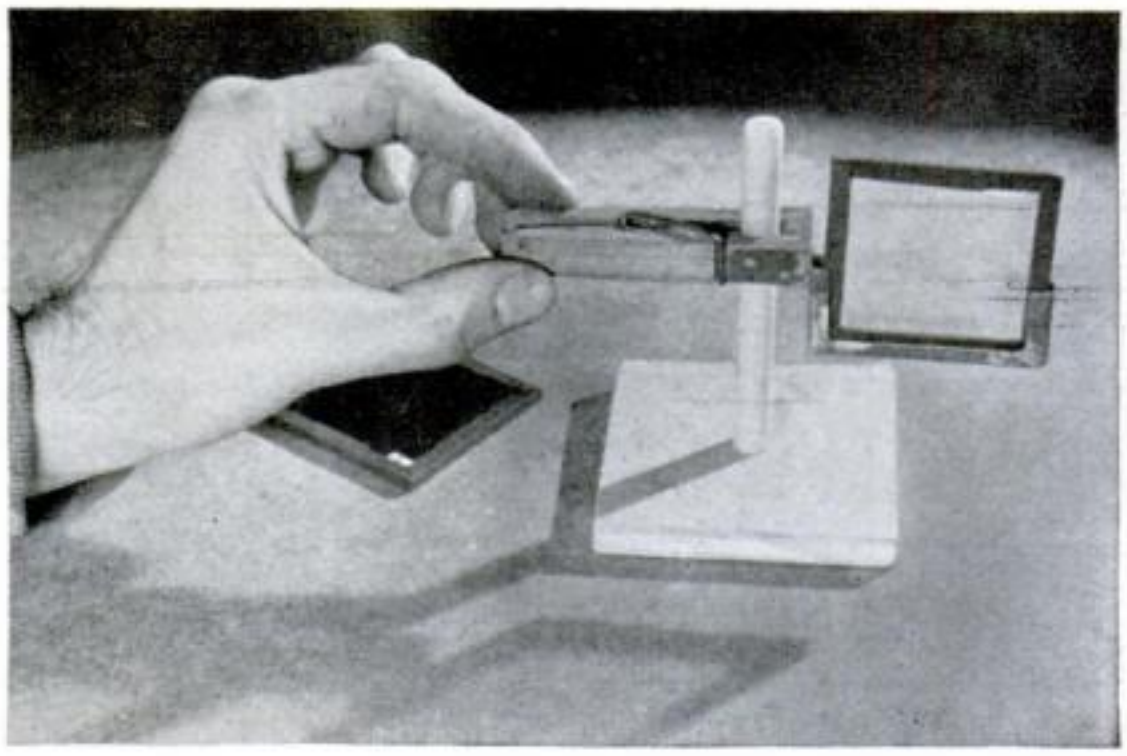
The box camera and the focusing screen are mounted on a swinging fan-shaped arm *C*. In one position, the ground-glass focusing screen is over the microscope for focusing the image, and in a second position the camera is there for taking the picture. Two L-shaped sheet-metal stops limit the swing of arm *C*.

Remove the inside film-carrying mechanism of the camera so as to give access to the lens at the back. Then remove the lens. Usually this can be done by springing a wire ring out of the hole in which the lens rests. Next, remove the front end of the camera and set the shutter on "time." If the shutter hole isn't large enough to pass the beam of light from the microscope (depending on the distance from eyepiece to camera), you can enlarge it and the one in the aperture plate with a reamer. The camera rests in a socket formed by 3/16" square strips of wood, and can easily be lifted off for loading.

Be sure the ground surface of the focusing screen is the same distance from the microscope as the film surface is. You can check this by laying a piece of ground glass on the film support when the camera is empty, and focusing on it.

The photomicrographs accompanying this article were made with the outfit illustrated, using orthochromatic roll film in the camera and a No. 1 photoflood lamp for illumination. An auxiliary condenser consisting of a ten-cent reading glass was placed between lamp and microscope substage condenser.

Light filters are, of course, used extensively in photomicrography. They are always placed between the lamp and the microscope stage. You can purchase 2" by 2" or larger pieces of colored gelatin (known as Wratten light filters) and bind them between pieces of clean glass. With most microscopes, a green filter ("B") or yellow and blue ("G" and "H") used together will produce the sharpest results.



This filter holder is easy to make . . . dowel rod set in square of plywood and snap clothespin fastened to light metal trough

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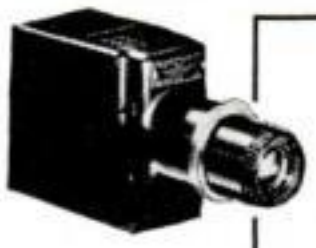

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**KODACHROME FILM** Eastman's film for gorgeous full-color "stills"

# You Can't Be Too Careful!

*(Continued from page 128)*

down some of the results of carelessness that come into the shop, and I've rounded up quite a collection. Two today, for example."

He told Dr. Marvin about them. "I get your point," the doctor nodded when he had finished. "I suppose you have had some other pretty queer ones, too."

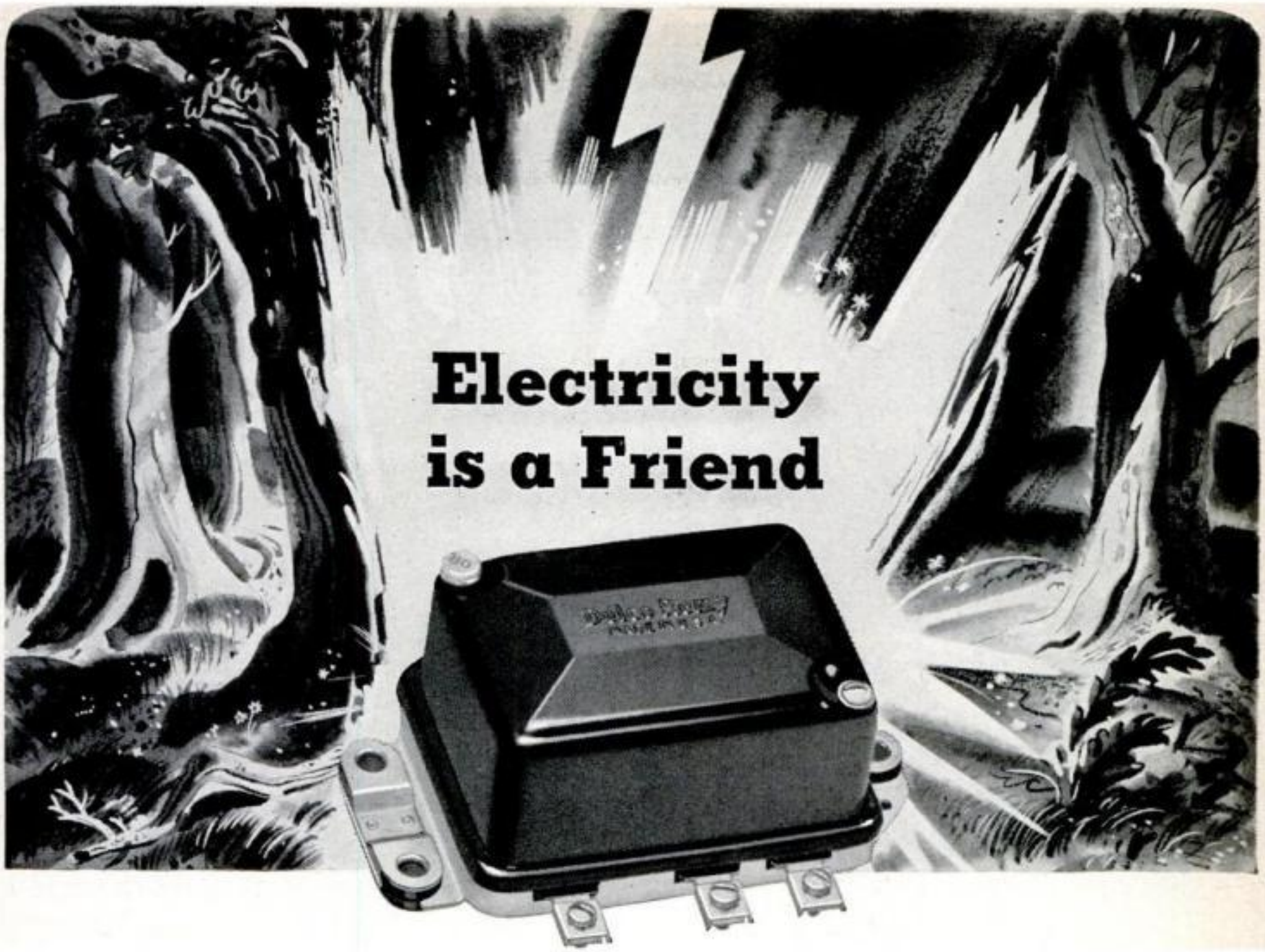
Gus thumbed through the pages. "Let's look at the record," he said. "Here's one. A fellow brought a car into the shop and said it suddenly had developed a terrible knock—he needn't have told me that, because I'd heard him coming! Sounded as if all the bearings had gone bad. I didn't find the cause of the racket until I'd taken off the head. Then I found a short piece of broken file sticking in the top of one of the pistons. Every time that piston came up the file hit hard against the cylinder head. The owner remembered that a few days earlier he had bought a new set of spark plugs in another garage, and that while they were being put in a mechanic working at a bench near his car had broken a file. Apparently the broken end had flown through the air and dropped down one of the spark-plug holes."

"I'd call that plain hard luck, rather than carelessness," Dr. Marvin objected. "Just one of those things that will happen."

"The mechanic was careless in not looking for the broken piece until he found it," Gus said. "You never should leave such things loose around a shop—they're likely to make all kinds of trouble. . . . Here's another one. Last winter, a woman drove a new car in, and complained that its heater wouldn't work. I checked the water pump and hose and all connections, and found them O. K. Then I tried to blow through the heater's inlet pipe, and found that it was clogged up. I put an air hose on it, and out came a mess of soggy sawdust. Cause: carelessness in packing the heater for shipment, and more carelessness in not checking it when it was installed. Some of the packing sawdust had got into it, and as soon as water got to the sawdust it swelled up and clogged the heater.

"Here's another one. A man drove in and said that his—"

Gus broke off and looked at the clock. Then he tossed the book into a drawer and reached for his coat. "I've got to beat it—going to the Millers' for dinner," he explained. "But you look through that book sometime, Doc. It proves something—that you can't be too careful!"




# . . . when it's under control

The current and voltage regulator on your car is the ever-alert watchman that controls the electrical output of the generator. If the generator output were allowed to "run wild," it would keep you busy and "broke" replacing ruined batteries, oxidized distributor contact points and burned-out lamp bulbs. The regulator allows the generator to supply just the amount of current required for the proper operation of all the electrical units —and no more.

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**Delco-Remy**

*World's Largest Manufacturer of Automotive Electrical Equipment*

# America Rolls Out the Warplanes

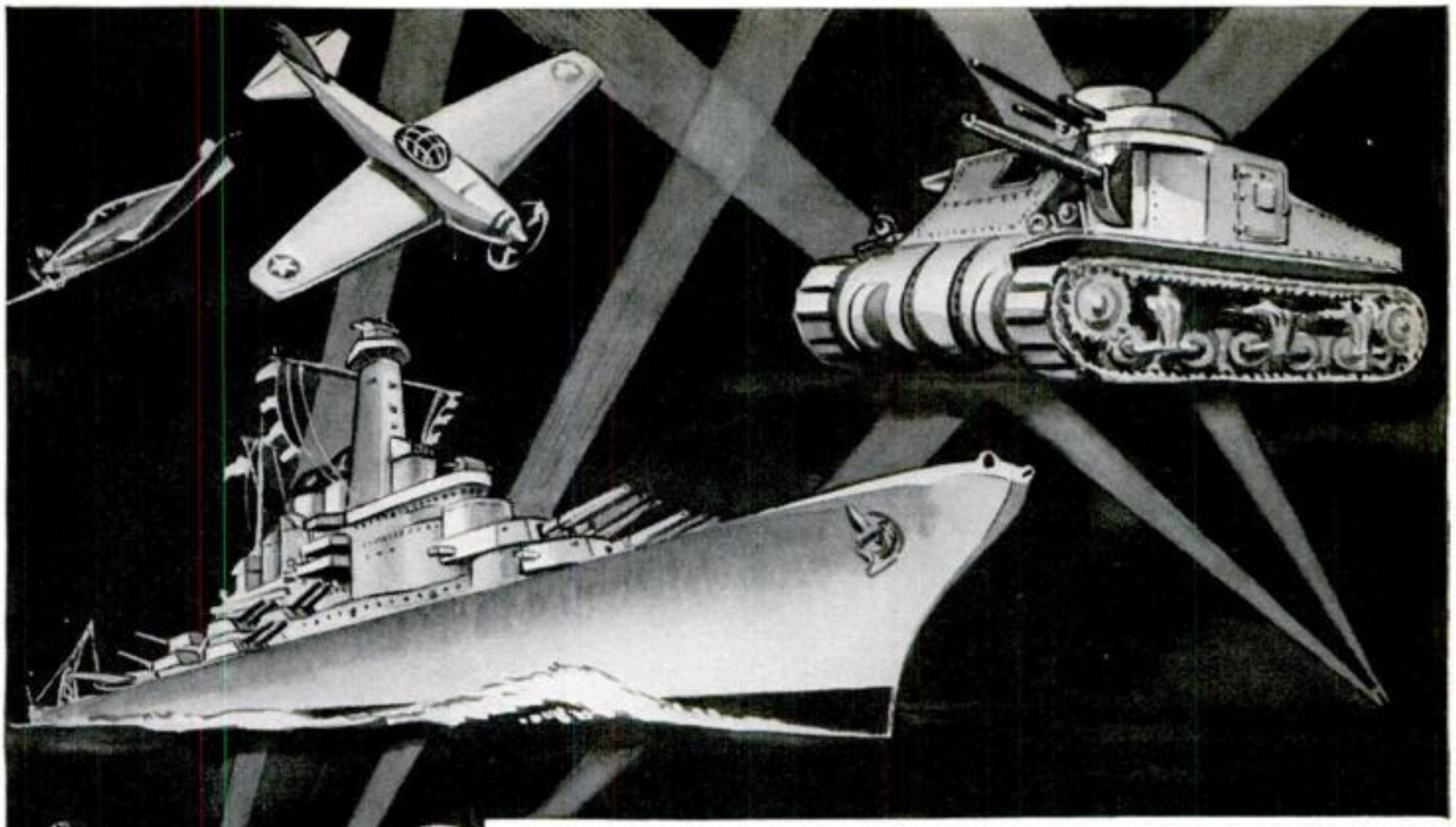
(Continued from page 73)

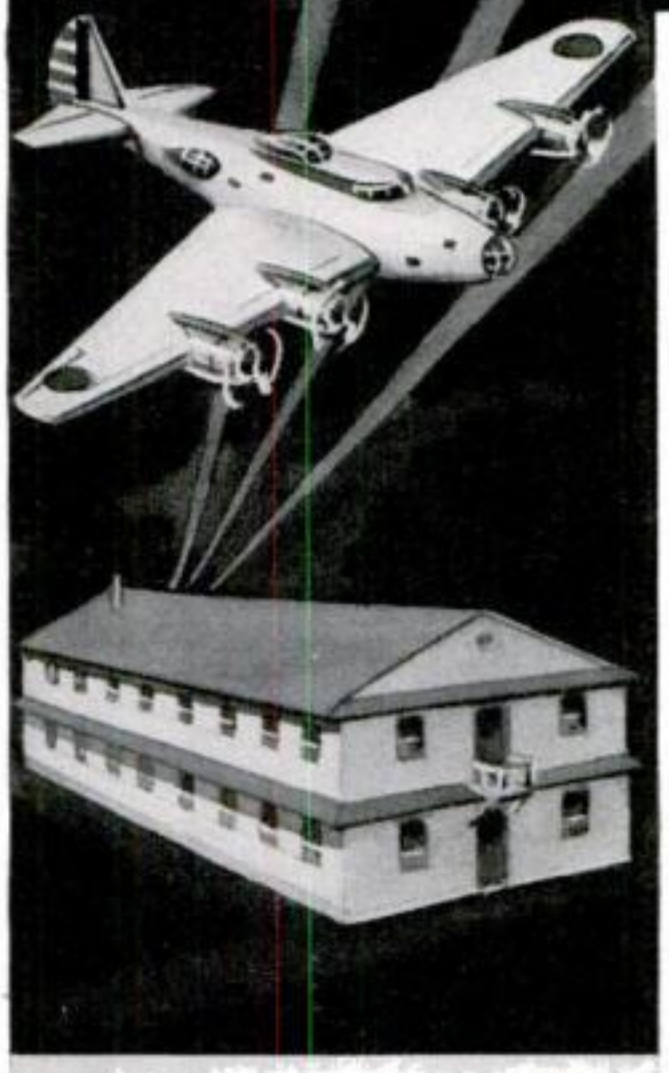
bombers, cargo planes, and other secondary military airplanes. The fact that the Navy has stuck consistently for years to air-cooled engines and brought out a Vought F-4-U fighter last fall which it announced as "the fastest airplane in the United States today," may have influenced the decision.

Although the twin-engined Lockheed P-38 pursuit has not yet been put in active service, some Air Corps officers have felt for a long time that the Army made a fundamental mistake in its original design by asking the designers to build a one-place rather than a pilot and observer-gunner airplane. They maintained that a twin-engined ship was "too much airplane" for one man to handle in a fight. Apparently the twin-engined German Messerschmitt 110, with its accommodations for a crew of two, and in some cases three men, has borne them out. While the first production orders of the Lockheed will be filled with single-place planes, subsequent models will carry a crew of two.

Reference has been made to the fact that two manufacturers, Wright and Pratt & Whitney, which for years have been the country's principal source of supply for military-aircraft engines, have continued to play this rôle in America's frenzied aerial rearmament program. They have accomplished this by one plant expansion after another at or near their respective original factories in Paterson, N. J., and East Hartford, Conn., and by judiciously guiding and building up a system of engine parts subcontracting which has helped to spread their burden among hundreds of manufacturing plants in other industries and thus augmented their own rate of production.

Furthermore, they have passed their product along for manufacture under license by automotive concerns—Pratt & Whitney to Ford and more recently to Buick, which is going to build its 1,200-horsepower, 14-cylinder radial engine; Wright to the Studebaker Corporation, which will build its 1,700-horsepower twin-row Cyclone, and to Continental, which already is building the 420-horsepower Wright Whirlwind both for training planes and for the Army's 28-ton medium tanks. And even now, a big new factory at Cincinnati, duplicating Wright's Paterson set-up, is beginning to turn out high-horsepower engines under the company's own management, but with a high percentage of parts produced by automotive and other manufacturers.



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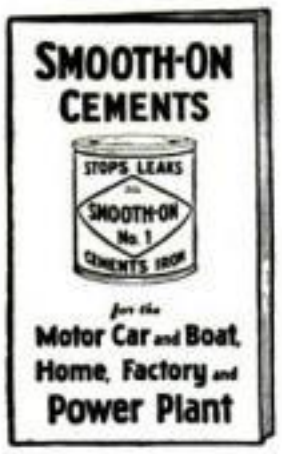


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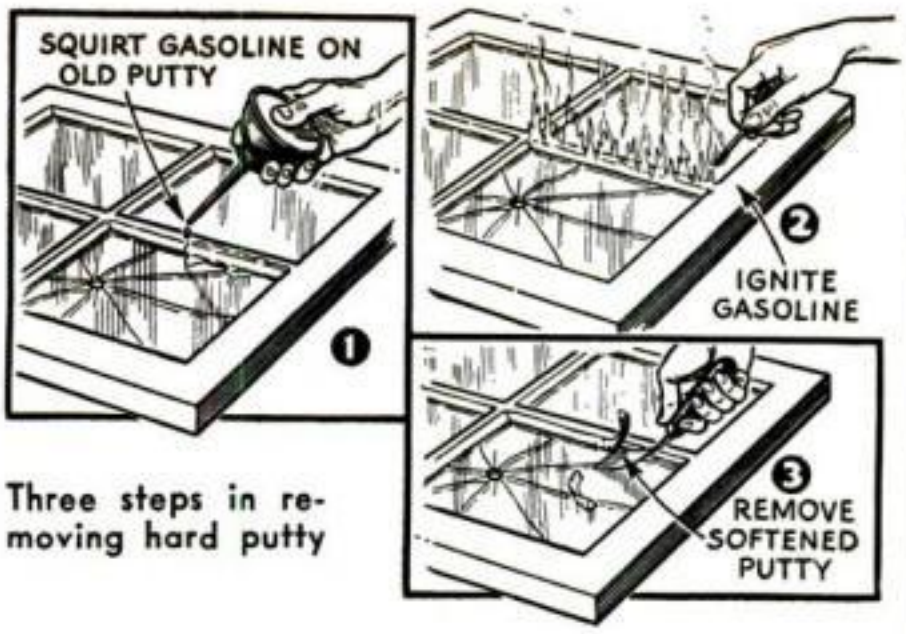


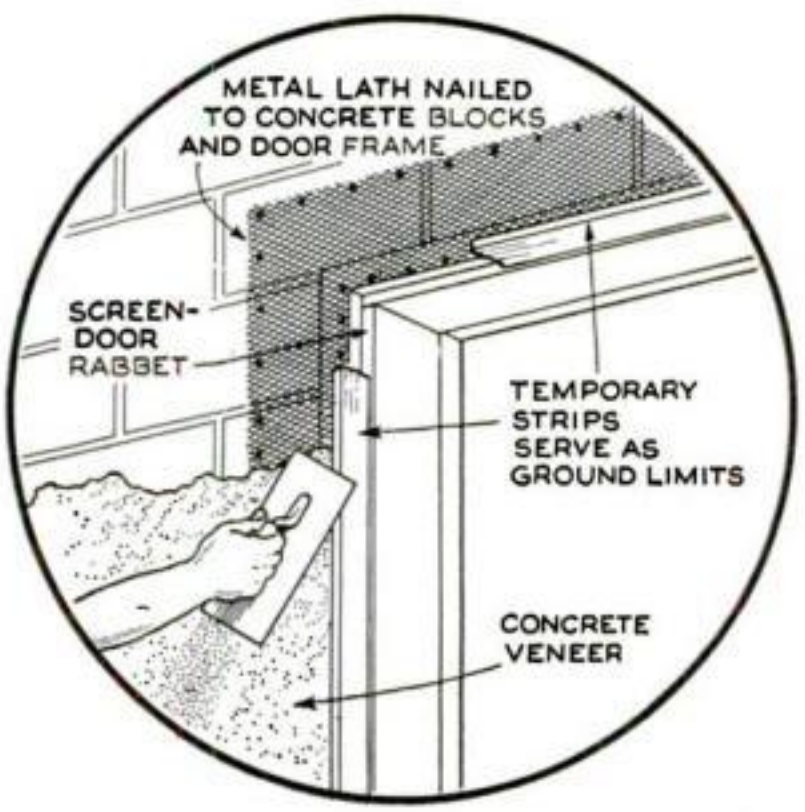

Three steps in removing hard putty

## Blazing Fluid Softens Putty So It Is Easily Removed

TO REMOVE hard putty encountered when reglazing sash, pour a small amount of any inflammable fluid, such as turpentine substitute, wood alcohol, or gasoline, over the putty and ignite it. The fluid will burn out rapidly and leave the putty soft enough to be removed easily with a chisel. An old oil-can makes a handy container, but put it well out of the way before setting fire to the liquid.—R. O. L.

## Troweling a Cement Coating Right Up to a Doorway

WHERE a facing or veneer of concrete is applied directly over a concrete-block building, the doorway can be given a modern appearance by running the coat clear to the actual door opening, as illustrated. Metal lath can be used around the door frame. To serve as temporary ground limits while troweling on the cement, wooden strips should be nailed in the screen-door rabbet of the frame.—J. MODROCH.



# Blueprints for Building Roomy Sport Boat

FROM the photo above it can be seen that Bill Sharpe, of Buffalo, N. Y., who built this shipshape runabout from POPULAR SCIENCE plans, is ready to make the most of the boating season. Months of vacation pleasure can be yours also if you construct this sturdy, versatile craft. It can be powered with either an outboard or inboard motor. The plans show how to build the seats to form bunks, so that the design combines the style and speed of a runabout with the utility and roominess of a light cruiser. Blueprints and instructions (Nos. 175-176-177-R) are $1.00, or, with specially drawn full-size patterns, $2.50.

For our illustrated boat-blueprint list, or for a complete list of plans for models, furniture, and other worth-while projects, send a stamped, self-addressed envelope.

**BOATS**

All-Purpose Boat, 11′ 5″ long, 331-R..... $ .75
Camper's Utility Boat, 11′ 2″ long, canvas-covered, for outboard motor or rowing, 281-R .50
Canoe, 16′ canvas-covered kayak; can be used with sail, 192-193-194-R..... 1.00
Canvas-Covered Duck Boat, 13′ 6″ long, 279-R.... .50
Cruising Sailboat, 19′ long, weighs 700 lb., Marconi sloop rig; can be used with 1 to 4 h.p. motor, 400-401-402-403-404-R..... 2.00
Family Runabout, 13′ 5½″ long, weighs 275 lb., for outboards from 1 to 60 h.p.; can also be rowed, 378-379-380-R..... 1.50
Fisherman's Outboard Boat, 9′ 3″ or 11′ 6″ long, weighs 115 or 160 lb., for motors from 3 to 16 h.p.; can also be rowed, 344-345-R..... .75
Inboard Boat, 15′ long, for motors from ½ to 5 h.p.; can also be rowed, 384-385-R..... .75
Lapstreak Skiff, 13′ 9″ long, weighs 225 lb., for 1- to 16-h.p. outboard motors, 363-R..... .50
Midget Boat or Pram, 9′ long, weighs 75 lb., for oars, sail, or outboard motor, 339-R..... .50
Motorboat-Rowboat, 13′ long, decked hull, for use with outboard or inboard drives, 147-R .50
Same, 14½′ long, 148-R..... .50
Same, 16′ long, 149-R..... .50
Plywood Dinghy, 9′ 7″ long, weighs 60 to 75 lb.; can be rowed, sailed, or used with small outboard motor, 387-388-R..... .75
Racing Runabout, 13′ stepless hydroplane for outboard motor, 261-262-R..... .75

*(Continued on page 209)*

# Plans for Tested Projects

(Continued from page 208)

Racing Sailboat BLACKCAT, 13' 4" long, weighs 250 lb., Marconi rigged, 321-322-323-R——$1.00
Runabout, 15' 6" long, weighs 550 lb., can be used with outboard or inboard motors of from 1 to 60 h.p., 175-176-177-R..... 1.00
Sailboat, 12' long, weighs 200 lb.; has fast skimming-dish hull, 314-R..... .50
Sectional Rowboat, 9' 8" long, two sections, weighs 60 lb., all-wood construction; can be used with small outboard motor, 340-341R.... .75

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Hanging Wall Cabinet, 9½" by 24" by 41¾", 280A .25
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Upholstered Stool, 240A..... .25

### MODELS

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Clipper Ship SEA WITCH, 9½" hull, 219..... .25
Confederate Raider ALABAMA, 21½" hull, 335-336-337-R ..... 1.50
Fishing Schooner WE'RE HERE of "Captains Courageous," 9½" over all, 351-R..... .50
Liner QUEEN MARY, 10¼" hull, 283..... .25
Miniature Fleet of Nine Modern U. S. Fighting Ships (full-size plans and instructions in booklet form), 372-R..... .50
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### MISCELLANEOUS

Aluminum Relish Dish, Turned Nautical Match Holder, Daylight Screen for Color Slides, 409A .25
Bronze Hammer, Rolled-Edge Metal Tray, Table Centerpiece for Easter (rabbit hitched to wagon), 407A ..... .25
Colonial Design Doll's House, 72..... .25
Doll's House Furniture, 73..... .25
Folding Wall Brackets (turned), Treble-Clef Bud Vase (metal or plastic), Vacuum Cleaner Attachment Rack, 408A..... .25
Garden Trellises—Four trellises and one sundial post, 34 ..... .25
Outdoorsman's Lightweight Trailer, 10' long, 4' wide, 4' 9" high, kitchenette on back, 300-301-R ..... .75
Projector for Photos and Pictures, 259A..... .25
Turned Table Lamp, Deringer Pistol, and Weather Vane (woman watering garden), 406A..... .25
Workbench for Home Shop, 24" by 58" by 34¼" high, 405 ..... .25

### LEAFLETS AND BOOKLETS

Hints on Cutting and Drilling Glass..... .15
Home Workshop Index for 1940..... .10
How to Build and Operate an Inexpensive Arc Welder and Spot Welder..... .50
How to Make Your Own Marionettes..... .50
Workbenches and Tool Cabinets (leaflet)..... .10

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# Assembly-Line Cities

*(Continued from page 99)*

Jubilant prefabricators are confident that the Government's building will make nation-wide a trend to prefabrication which began a year or so ago in the Middle West. Three fourths of the new homes built at Lafayette, Ind., in 1940 at a cost of $4,000 or less were prefabricated, and PHC, without putting its houses on the market, received inquiries from 8,000 individuals as the result of a single magazine article.

Erection of 500 homes for shipyard workers near Camden, N. J., last spring provided an almost exact time and cost comparison between prefabrication and conventional methods of building. The Day Housing Corp., of New York City, headed by the auctioneer, Joseph P. Day, built, at a factory set up for the purpose at near-by Gloucester, wooden frames and sheeted panels for 444 units, and the Wheeler Engineering Co., of New York, erected them. At the same time Wheeler built 28 two-family units on the site, in the usual way, and out of the same materials. The Day houses were only partially prefabricated, and therefore required more time for finishing at the site than fully prefabricated houses. Nevertheless, considerable time and money were saved over conventional methods.

To house defense workers while homes were being built, the Government has used temporary dormitories, trailers, and, for a time, river steamers. In March 2,035 trailers were ordered to ease the shortage of houses at San Diego, Calif.; Wilmington, N. C.; Baltimore; Erie, Pa.; Sidney, N. Y., and Nashville, Tenn. Dormitories were built at San Diego to house 1,000 men; at Bremerton, Wash., 500; Orange, Texas, and New London, Conn., 400 each; Baltimore, 300; Nashville, 200, and Sidney, N. Y., 100.

The cost of all this defense housing will exceed two billion dollars. The Army alone has spent $947,000,000 the last year, and that does not include the houses built for it by other agencies to shelter married enlisted men and the Army's civilian employees. The Navy is spending $50,000,000. The Defense Housing Coördinator estimated last summer that the total cost of housing industrial defense workers would be around $700,000,000, and he has raised his sights on the number of homes needed since then. His working capital then was $290,000,000 and it was all spent, or earmarked, by early in March. As most contracts are let on a cost-plus-fixed-fee basis, it is impossible to determine the final costs until the houses are actually completed.

# Poison-Gas Defense

*(Continued from page 104)*

¾ pound of an intimate mixture of 80 percent activated charcoal and 20 percent soda lime, which is composed of hydrated lime, cement, kieselguhr, sodium hydroxide, and water. The mechanical filter consists of a cylindrical sleeve made of fibrous material of such fine porosity that the solid particles of toxic smoke are screened out of the air passing through the material.

The inhaled air enters the canister through a rubber disk inlet valve in the bottom and is drawn first through the mechanical filter where any solid or liquid particles are screened out. The air then passes through the chemical contents of the canister where the toxic vapors are absorbed by the charcoal or neutralized by the soda lime. Gases which the charcoal does not hold firmly by absorption (for example, phosgene) are gradually released by it and are caught by the soda lime, with which they enter into chemical combination.

The hose which connects the canister to the facepiece is a corrugated rubber tube covered with cotton stockinette. The corrugations preserve flexibility and prevent the tube from collapsing.

The carrier is a canvas satchel provided with adjustable shoulder and waist straps which permit it to be carried at the left side under the arm. The opening at the front permits the mask to be adjusted to the face without changing the position of the carrier as was necessary with our World War masks.

Another recent improvement in the Army service mask is the development of a sound-transmitting diaphragm which is mounted in a specially designed angle tube and permits clearer transmission of oral commands and telephone conversation. Diaphragm masks may also be made with special eye lenses adapted to fit observing instruments, such as range finders and telescopes, and are then known as optical masks. These are issued only to soldiers having duties requiring them to use optical instruments.

Recently developed in this country, the so-called "training mask" was designed for the purpose of supplying the Army with a cheap and lightweight gas mask for training purposes. It differs from the standard Army service mask, not only in design and construction, but also in the process of manufacture which embodies many of the latest innovations in gas-mask production. The training mask is of the snout-type—that is, the canister is attached directly to the facepiece, thereby eliminating the hose tube. As

compared with the service mask, the training mask is lighter in weight, has a smaller canister, and the facepiece is fully molded, instead of fabricated, into final shape.

The facepiece of the training mask is of universal size, with an integrally molded air-supply tube and deflector. The eyepieces of cellulose acetate are crimped on the facepiece and are not round, as in the service mask, but are specially shaped to afford maximum vision. The facepiece fits closer to the face and thus reduces to a minimum the dead air space within the mask. The outlet valve is of the circular disk type and seats against a molded rubber seat within the angle tube.

The canister is cylindrical in shape and somewhat smaller than the standard service canister. It, however, contains the same kind of chemical contents and has a mechanical filter for removing toxic smoke. Air enters through an inlet valve in the bottom of the canister. Since the training canister is smaller than the standard service canister, it has a shorter life in gas concentrations and a higher breathing resistance. It will, however, protect against all standard chemical agents with a degree of protection equal to the standard canister.

The carrier of the training mask is a lightweight cloth bag with a single adjustable shoulder strap which is held against the left side of the body by a cord passing around the waist.

By molding the facepiece instead of fabricating it, as in the standard service mask, not only is the process of manufacture simplified about 20 percent, but the number of inspections for leaks and defects during the process of manufacture is greatly reduced.

The latest type of gas mask developed in this country by the Army is the so-called noncombatant mask, which is intended primarily for the protection of civilians whose duties require them to remain in the theater of military operations where they may be exposed to toxic gas. The noncombatant mask is of the snout type with a facepiece composed of laminated gasproof fabric, and is equipped with the same six-strap elastic head harness as the service mask.

The noncombatant mask is of the universal type and will fit practically all persons, except babies and very small children who require special types of masks. Although it is not of the diaphragm variety, the resonant quality of the facepiece fabric transmits conversation to a considerable extent.

The canister of the noncombatant mask is cylindrical like the training canister, but is somewhat smaller and of lighter construction. It provides protection against all known war gases in the same manner as

*(Continued on page 214)*

# Poison-Gas Defense

*(Continued from page 213)*

does the service mask but is not designed for the long life and rugged use of the service mask. The total number of hours it will protect against high field concentrations of gas is also less than with the service mask, but since such concentrations cannot be maintained for more than a few hours under average conditions, the protection afforded by the noncombatant canister is ample for the purpose it is intended to serve.

In time of peace, military masks are manufactured in the United States only in Government arsenals. In time of war or national emergency, the production capacity of the arsenals is far too small to meet the demand and resort is had to supplementary production by private industry, using dies and patterns provided by the Army. For this purpose certain commercial firms engaged in similar lines of work are selected to manufacture masks in time of peace, after a survey is made of their facilities. When an emergency arises, contracts are placed with these firms on a cost-plus-fixed-fee basis. Since the beginning of the present emergency, several private companies have been engaged in manufacturing gas masks in whole or in part.

The cost of manufacturing gas masks varies considerably depending principally upon the type of mask. Thus the relative costs of the several types of masks mentioned above are approximately as follows: noncombatant mask, $3.00 apiece; training mask, $4.00; service mask, $7.75; diaphragm mask, $10.50; and optical mask, $10.00. The cost of American gas masks is higher than that of corresponding types of foreign masks. This is due, not only to our higher labor costs, but also to the superior construction of our masks.

While the gas mask protects the respiratory organs and the face, it does not protect the body against vesicant or blistering gases, which readily penetrate ordinary clothing, leather and even rubber and produce incapacitating burns. For full protection of the body against vesicant gases special protective clothing is required. Such clothing consists of a complete outer garment or suit of oilskin with hood, and specially treated heavy rubber gloves and boots. For civilians a light oilskin cape with hood affords sufficient protection until refuge can be taken in gasproof shelters.

As masks and protective clothing are uncomfortable and must be removed when eating, drinking, and sleeping, it is necessary that additional means for protection against

gas be provided. Such a means is the gas-proof shelter which is a refuge room made air-tight and supplied with pure air through a chemical filter. A slight plenum is maintained in the shelter so that the movement of air is always from inside the room to the outside. This insures against gas entering the shelter from the outside atmosphere.

The air supply for the shelter is secured by means of a rotary air pump, driven manually or by electric motor, depending upon its size. The air is drawn in from outside the shelter through a chemical filter which is constructed on the same principle as the gas-mask canister. Gas shelters vary in size from small family units for four or five people to large public shelters accommodating as many thousands.

Decontamination is the process of destroying toxic gases, especially vesicants such as mustard, in order to clear materials, buildings, or areas that have become dangerous to life by contamination with toxic gas. The principle of decontamination is simple and consists essentially in applying a gas-neutralizing agent to all contaminated surfaces as soon as possible after contamination.

In actual practice, decontamination is attended with many practical difficulties owing to the insidious and dangerous character of vesicants and the effort and skill required to determine the exact areas to be treated and the great care necessary to insure that all traces of gas have been removed.

The best all-around agent for chemically neutralizing vesicants is ordinary bleaching powder (chloride of lime). This material reacts vigorously with vesicants and converts them into harmless compounds. The bleach may be applied in the form of dry powder, mixed with earth or sand to prevent combustion, or in the form of a paste or liquid solution in water.

In liquid form the bleach may be sprayed with an ordinary spraying apparatus. A mobile sprayer for decontamination work consists of a 20-gallon tank fitted with a hand pump and two spray nozzles, each with fifteen feet of hose.

The protective measures which we have mentioned are but a small part of the total effort required to prepare for adequate chemical defense. When all its many ramifications are considered, chemical defense is indeed a formidable problem, but one which must, nevertheless, be solved if we are to escape the disasters due to gas of the last war but on a vastly larger scale. In fact, the best insurance against employment of chemical agents by an enemy is the knowledge that our country is fully prepared to defend itself against the use of all types of chemical agents, and our Army is ready to retaliate promptly if they are used against us.

# Army's Nerve System

*(Continued from page 94)*

control and precise calibration of instruments prevents this system from becoming a mere babble of waves in a jammed atmosphere. Most of the sets operate as silent receivers, authorized to transmit only in emergencies. Even so, the whole matter takes on a complex precision which is almost beyond the imagination of those of us accustomed only to the fuzzy tuning of our home radio sets. The frequencies used, and the techniques of avoiding confusion, are among the closely guarded secrets of the Signal Corps. But one method which seems sure to make forward leaps is frequency modulation, the new staticless form of radio. FM not only adds new channels; it also eliminates the interference set up by the ignition of thousands of near-by gas engines.

As thus shown in the Armored Force, and also in the air squadrons, the instruments of communication tend today to come more and more into the hands of the combat soldier, intensifying the Signal Corps' rôle as a body of specialists superimposed on the Army's basic organization. The most striking example of this is the tiny voice transmitter, powered with dry cells, known as the "walkie-talkie." Carried in a pack, this little radio telephone weighs only 25 pounds, half a soldier's ordinary load.

Obviously adapted to such melodramatic uses as those of parachute troops or small reconnoitering parties, the "walkie-talkie" has far more basic value. The artillery, for instance, has responsibility for maintaining liaison with the infantry it is supporting; and in the World War more artillerymen were shot in repairing telephone lines to the trenches than in any other way. Today such losses would be unnecessary. When the wires go out, the radio takes over.

Twenty years ago, when the infantry first asked for the development of a radio which one man could easily carry, the idea was an utter technical impossibility. But years of research by the Signal Corps laboratories, as well as by industrial designers who worked out the little spot-news broadcasters used by the radio chains, have developed devices of amazing simplicity.

Today the walkie-talkie is standard equipment for front-line troops, and is but the smallest of a whole family of instruments grading up to the heavy fixed-station transmitters, all specially and ruggedly designed for rough usage in the field. In the World War, a radio station was a heavy affair with a gas engine and hundreds of pounds of equipment. Today, a front-line transmitter

with range of several miles is hardly twice the weight of a walkie-talkie, its antenna is a small loop, and its power is provided by a tiny generator turned by hand cranks.

These small outfits are designed, provided, and maintained by the Signal Corps of the Army, which operates in units attached directly to the higher headquarters. In operations the Signal Corps is responsible for all communications down to the next unit below division headquarters, brigade or regiment as the case may be. The smaller units handle all their own signaling, with equipment provided by the Signal Corps.

The signal service of a field army includes two signal battalions and several specialized companies; an army corps has one signal battalion; and each division has a signal company attached to headquarters. These units, broken down into specialized platoons and small teams, are capable of a great variety of simultaneous operations.

Ordinarily the Signal Corps amounts to about three percent of the Army, but under the pressure of the last few months it has expanded even more rapidly than the military establishment as a whole. Last spring it amounted to 35,000 men and 1,300 officers, exclusive of National Guard units, and its training post at Fort Monmouth, N. J., had multiplied from a strength of only 800 to nearly 12,000.

Here signal technicians are being turned out by mass production. The Signal School gave specialized three-month courses during the last year to more than 3,000 enlisted men and officers, and is scheduled to put through at least 6,000 more during the year just beginning. For newly inducted men a Replacement Training Center was opened in March, and in the next three months gave basic training to nearly 6,000 as linemen, radio, teletype, and telegraph operators.

Fairly competent operators, for radio, telegraph, and teletype, can be turned out in three months; and they speed up with further practice. Accuracy is the primary thing, for a military message has no sense to guide a man in sending it. Except when an armored column is moving so fast that secrecy is no object, and radio can be "in the clear," military messages are sent in code (with groups of letters substituted for other meanings) or in cipher (with letters substituted for those of the actual message so as to make an apparently incoherent jumble). The typical military message is a sequence of five-letter "words" which are merely mixtures of letters with no apparent meanings. The Signal Corps has mechanical devices which speed up the process of mixing and unmixing the cipher, but that is no help to the operator, who must be contin-

*(Continued on page 218)*

# Army's Nerve System

*(Continued from page 217)*

ually transmitting a letter-perfect stream of alphabet soup.

The ingenuity of cryptography is exceeded only by the art of cryptanalysis, the solving of the secret ciphers of the enemy. This whole field is one of the special concerns of the Signal Corps, not only as to maintaining the security of its own messages, but also breaking down and reading the codes of the enemy. The enemy is supposed to be so good at this kind of puzzling that any code can be broken down in from six hours to three days at the most. In enciphering messages it is routine, in addition to changing the key frequently, to change the method of jumbling the letters, after every five words.

Attached to each field army is a radio intelligence company, capable of operating many stations on a 24-hour basis to intercept enemy messages, and also a number of radio direction-finding stations over a front of 35 miles. A radio direction finder, with a loop antenna rotating on a vertical axis, is able to take a precise bearing on any selected station. With two or more such bearings from different points, the location of an enemy transmitter may be obtained very quickly, in much the same manner as ships navigate by radio bearings.

America has real reason, in this emergency, to be thankful that its communications system is the most highly developed in the world. Its related industries have developed rapidly during the last quarter century, and all the new devices of printers, teletypes, facsimile, multiple circuits are quickly adaptable to army use, to carry the heavy traffic between headquarters. The skills of wire management and maintenance are so widespread that it is almost no problem to get the men for the job.

But radio is the competitive frontier, and here at the moment there is no reason for complacency. A nation of knob-turners does not thereby become a nation of radio technicians. Repair for the radios of thousands of tanks is bound to become one of the Army's greatest problems.

But that need won't become acute until the tanks start rolling off the assembly line, and then the radio industry will really come into its own as a basic factor in defense. America can tell the world that its radio industry produced 11,000,000 radio sets last year, and 110,000,000 tubes, an increase of 2,000,000 sets from the year before. These small army portable sets are not very complex. The industry can easily supply them, and repair men too.

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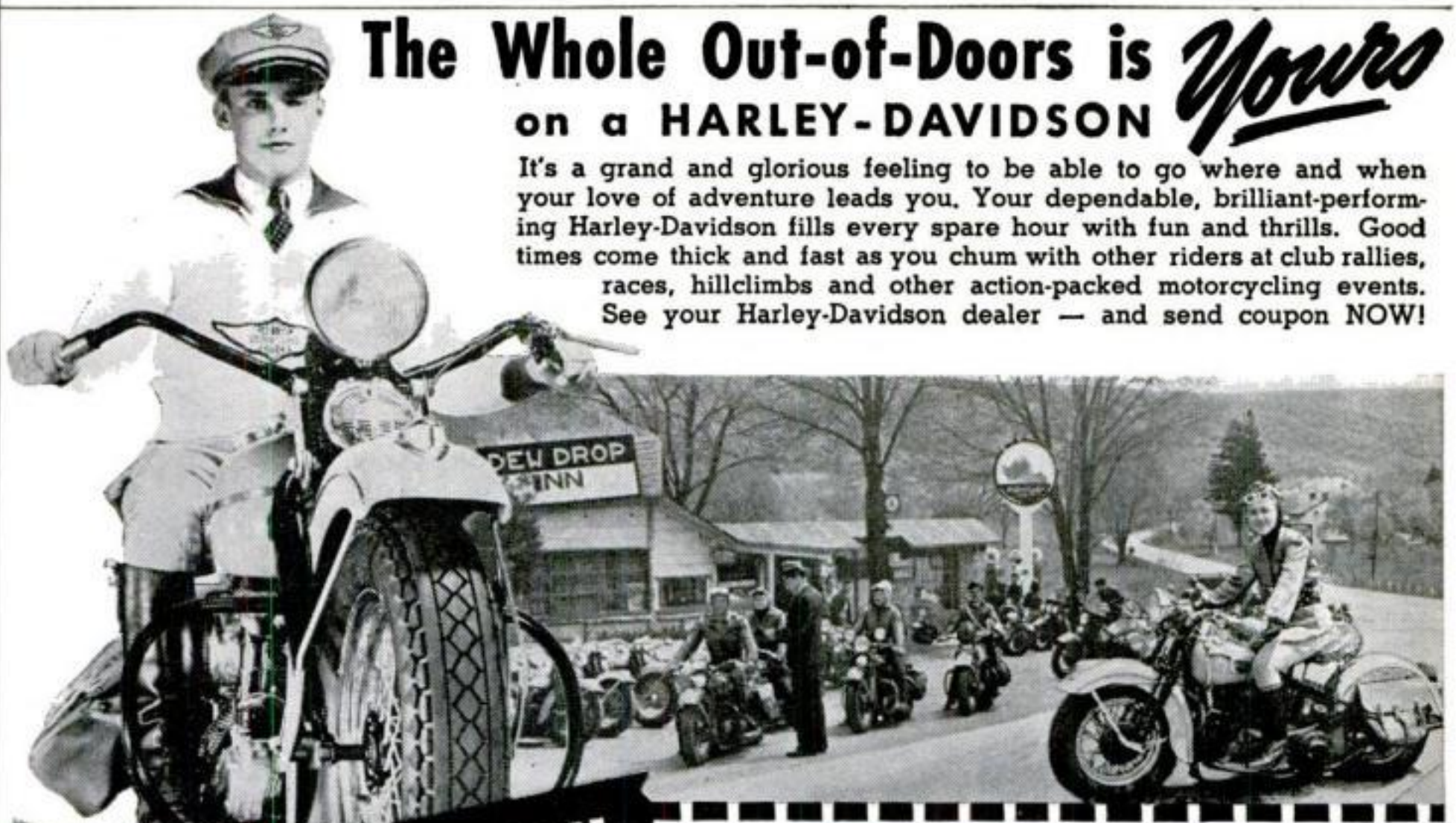


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# Chemurgy as a Weapon

*(Continued from page 107)*

a 2,000-pound bomb falling 15,000 feet will penetrate six feet of reënforced concrete. The cotton can be made resistant to fire.

Large chemurgic progress has been made with corn, the outstanding American crop. Zein, a protein by-product of cornstarch, lends itself to the manufacture of yarn, buttons, laminated boards, wall-paper coating, quick-drying printing ink, tin-foil substitutes. As Zein for industrial use brings 15 to 20 cents a pound, it has been estimated that from 40 to 60 cents may be added to the value of a bushel of corn.

Chemurgists are vitally interested in making the United States as self-sufficient as possible. They are greatly concerned over the reduction of imports. It has become evident when certain imports such as glycerin were forcibly cut off, that they could be economically produced here. Starch, a heavy import, may be made from white or sweet potatoes with stock feed as a by-product. The fractional distillation of American oils can provide substitutes for imported oils, according to chemurgic conference reports. Chemurgists are agitating for the increased American production of flax for both linseed oil and linen (much in demand at present by the Army and Navy) and this has been made possible by the invention of a new flax-gin, the "decoriator" which does away with the old "retting" process.

While chemurgy will help national defense, the vast defense effort will surely help chemurgy. It has become a platitude that many processes are made commercially profitable when they are forced by a war economy to function on a large scale. The Haber-Bosch process for obtaining nitrogen from the air is a conspicuous example of this. So such things as the blending of alcohol with gasoline as a fuel—thought by Dr. Hale and others to be the most far-reaching chemurgic experiment—may become an accomplished commercial fact in America. This will reduce the drain on the oil wells and put millions of new acres into cultivation to the profit of the farmer.

The United States is thought the ideal chemurgic laboratory of the world because of its vast acreage of cultivable land, its agricultural tradition, and its present high position in chemical industry. For whereas most European nations must confine their limited land to food production, in America there has been a food surplus with consequent disaster to the producers. Chemurgists see a future in which both crop reduction and farm subsidies will disappear.

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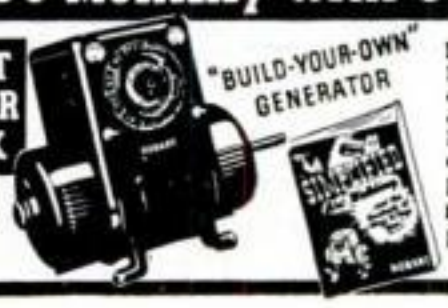


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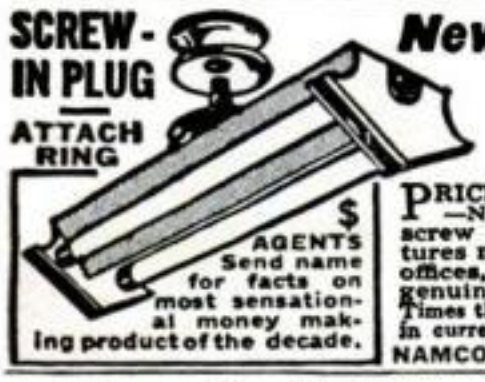

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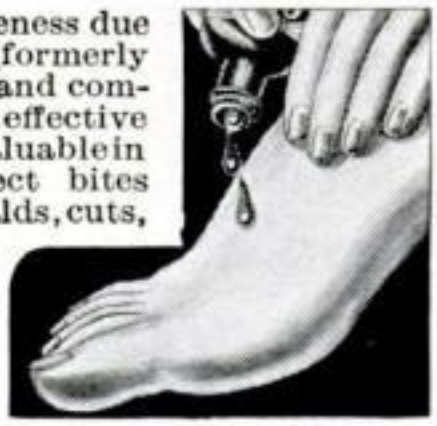

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These men need clubs . . . places where they can go for recreation and comfort in the evening . . . places where they can rest and relax and enjoy good companionship . . . places where they can have help and advice if they want it.

To provide such service clubs, six of America's most experienced organizations have banded together to form the U. S. O. (comprising the Y. M. C. A.; National Catholic Community Service; Salvation Army; Y. W. C. A.; Jewish Welfare Board; National Travelers Aid Association).

The U. S. O. will set up more than 360 of these clubs. The Government will supply the buildings . . . but to the American public belongs the responsibility of running them and financing them. The cost for the first year is estimated at $10,765,000.

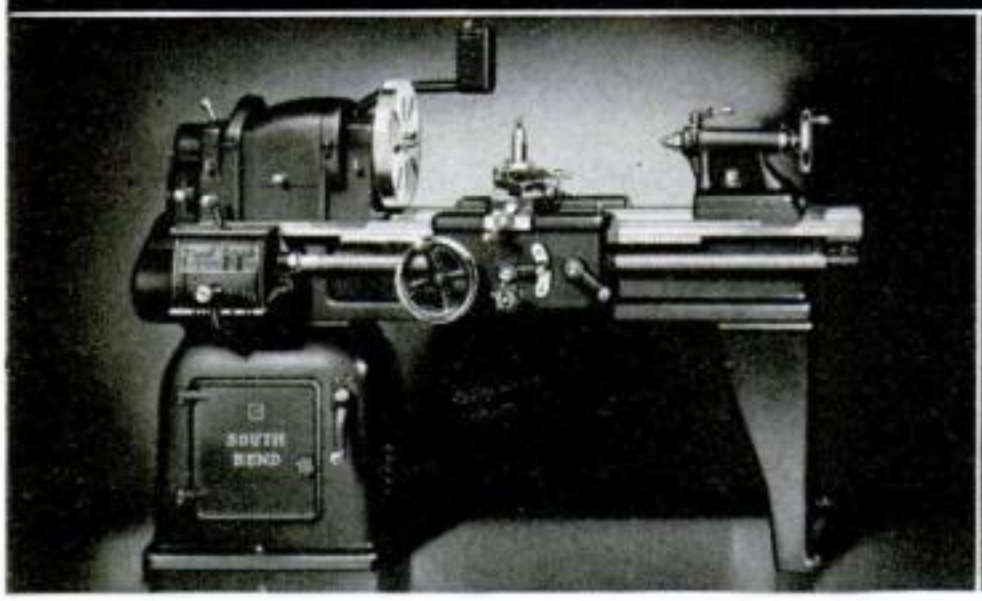
So, to you who have not been drafted, we say . . . here is the chance you have been waiting for to aid in national defense. And if you are getting more than $21 a month yourself, see if you can share some small part of it to make life more pleasant for those who *have* been drafted.

Will you join the army *behind* the Army? Say yes . . . today!

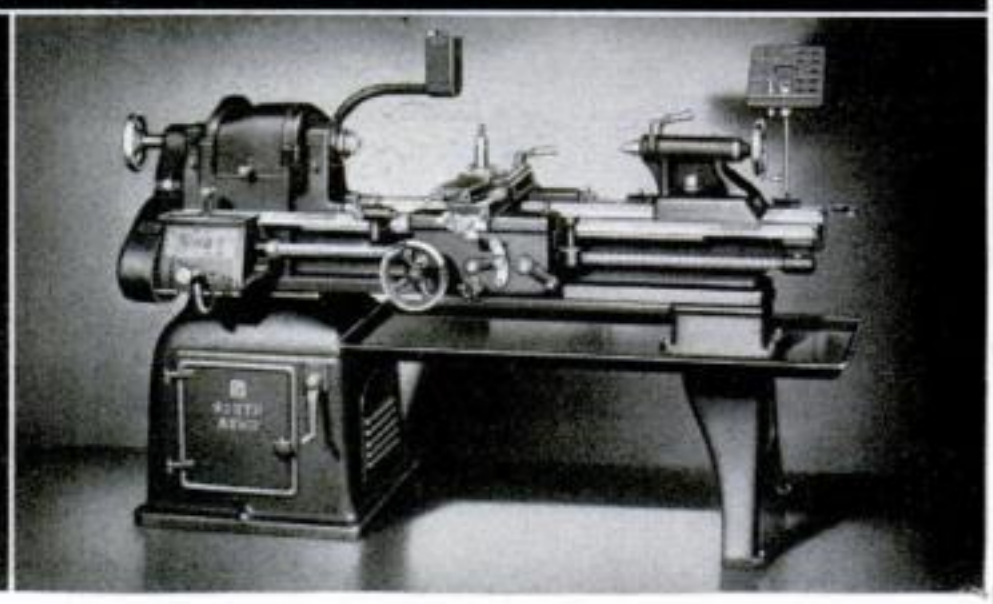
*Send your contribution to United Service Organizations, National Headquarters, Empire State Building, New York, N. Y., or to your local U. S. O. Committee.*

## Your Chance to Serve—Support the U★S★O

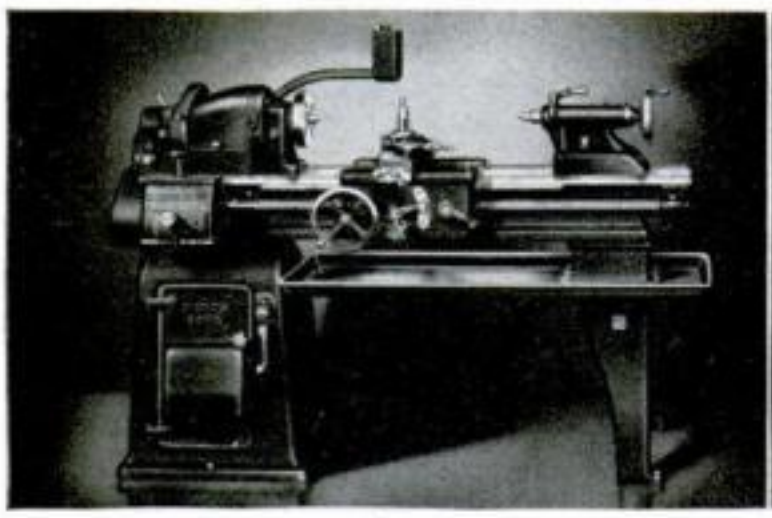
# *The* RIGHT *Lathe For Every Shop Need*



16" swing South Bend Underneath Motor Drive Quick Change Gear Precision Lathe.

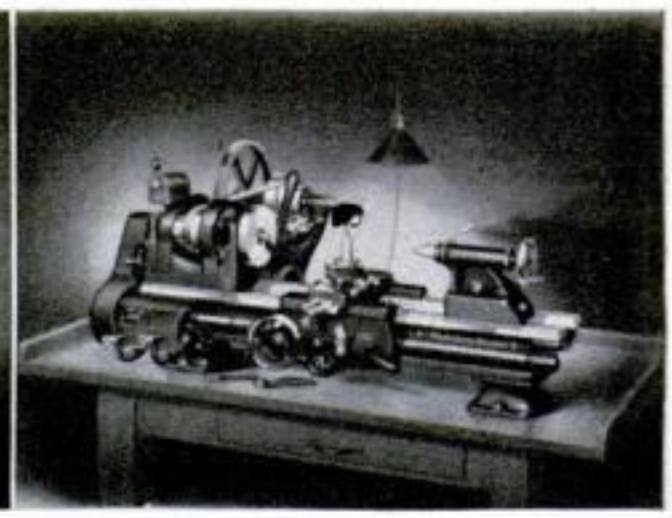


14½" swing South Bend Tool Room Underneath Motor Drive Precision Lathe.



13" swing South Bend Underneath Motor Drive Quick Change Gear Precision Lathe.

10" swing 1" Collet South Bend Tool Room Underneath Motor Drive Precision Lathe.



9" swing Model A South Bend Workshop Quick Change Gear Precision Bench Lathe.

THE importance of selecting the *Right* lathe for every shop need is emphasized today by the urgent demand for increased production resulting from our present national emergency. Maximum production at minimum cost can be attained only when the lathe is matched perfectly with the job.

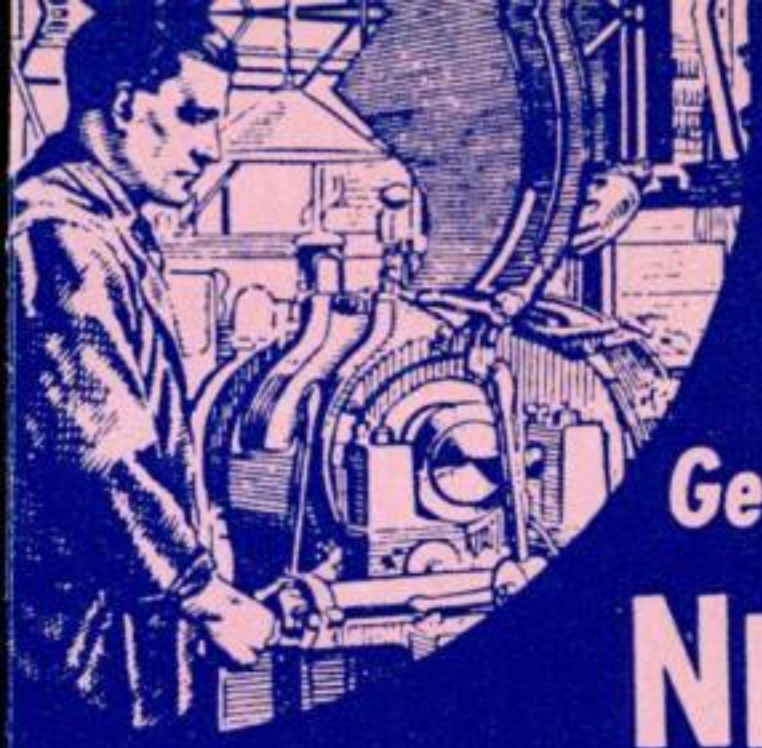
Consider the work to be done, then choose the size and type of lathe that will give you the most efficient service. Remember that versatility and precision are important in a tool room lathe. For manufacturing operations, a lathe must also have plenty of power, speed, stamina.

South Bend Lathes are made in a variety of sizes and types that will efficiently handle a wide range of metal working requirements. They can be supplied with equipment for precision tool room work, manufacturing operations, general machine work, and for many special classes of service.

Consult our Engineering Department about the lathe best suited to your work. We do no special tooling and make no special machines, but we will gladly give you our recommendation. A copy of our new Catalog No. 100A describing all sizes and types of South Bend Lathes will be sent on request.

**SOUTH BEND LATHE WORKS**

825 EAST MADISON STREET, SOUTH BEND, INDIANA, U. S. A.



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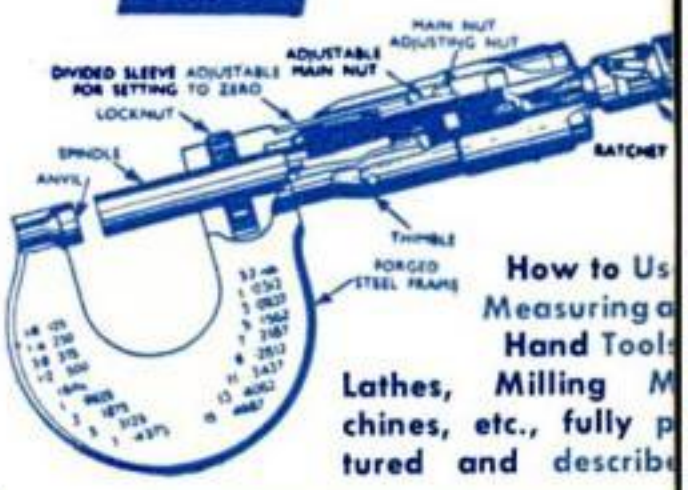


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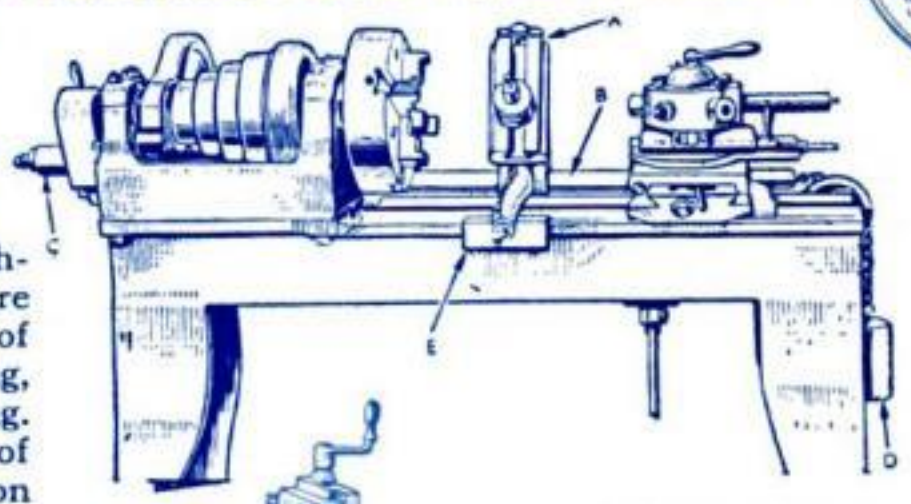
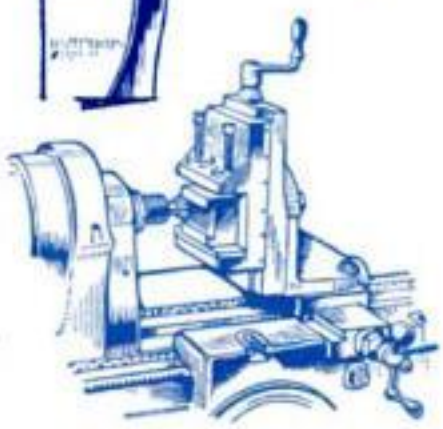



COMPLETE chapters in this volume are devoted to every type of Bench Work; different types of metal used by the machinist; Turret and Automatic Lathes, and their innumerable functions, attachments and operations. There are chapters covering every type of Screw-Cutting; Tape-Turning, Knurling; Milling and Grinding.

Included in the broad scope of this volume is full information on Special Machine Tools and Machine Attachments; Jigs and Fixtures; Punch Press Operations. Instruction is given in Heat-Treating of Metals; Welding and Soldering; Drop-Forging; Foundry Work; Gauging and Testing. Complete descriptions and explanations of all types of Calipers, Micrometers and other precision measuring instruments used by machinists are included. There is also a special chapter on Reading Machine Blue Prints. And there are dozens of tables designed to save time for the machinist and to simplify mathematical calculations.



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